7. WAG 1 ECOLOGICAL RISK ASSESSMENT

This Waste Area Group (WAG) ecological risk assessment (ERA) represents the second phase of the three phased approach to ERA (Figure 7-1). The approach applies an iterative, "tiered" process in which preliminary assessments, based on conservative assumptions, support progressively more refined assessments (Maughn 1993; Opresko et al. 1994; Levin et al. 1989). The three phased approach is discussed in further detail in Section 7.5, Transition to INEEL-Wide ERA.

The first phase is the screening level ERA (SLERA), which is a "preassessment" or data gap analysis performed at the WAG level. The SLERA phase reduces the number of sites and contaminants to be addressed in subsequent assessments. This screening is used only as a preassessment tool to: (1) better define the extent and nature of individual WAG sites of contamination and identify sites at which no contaminants of potential concern (COPCs) are found, (2) reduce the number of COPCs to be addressed in the WAG ERA by eliminating those that clearly pose a low likelihood for risk, (3) identify sites for which further data are needed, and (4) identify other data gaps. The screening also serves to support problem formulation and determine media and pathways to be evaluated for WAG ERA assessments. The results of the WAG 1 SLERA are reported in Attachment VIII of the OU 1-10 RI/BRA Work Plan.

The WAG ERA is the second phase in the INEEL ERA process and provides a site-by-site evaluation of the risks to ecological resources as a result of exposure to radiological and nonradiological contaminants at the WAG level. The WAG 1 SLERA was conducted to screen sites identified in the Federal Facilities Agreement and Consent Order (FFA/CO) (DOE-ID 1991) and to identify those contaminants present at WAG 1 that have the potential to cause undesirable ecological effects. The sites and contaminants identified as a result of the SLERA, in addition to those sites for which inadequate sampling information existed for inclusion in the SLERA are analyzed here, in the WAG ERA. This assessment was performed using the same basic methodology developed in the *Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL* (VanHorn et al. 1995). The results of this assessment will ultimately be integrated with similar assessments for other INEEL WAGs to support the performance of the INEEL-wide baseline ERA.

7.1 Objectives

The objectives of the ERA were as follows:

- Determine the potential for adverse effects from contaminants on ecological receptor populations and protected wildlife species (individuals and populations) at the WAG level
- Identify sites and COPCs to be assessed in the INEEL-wide ERA
- Provide input to the data gap analysis for the INEEL-wide ERA.

The INEEL approach for ERA was specifically designed to follow the direction provided by the EPA *Framework for Ecological Risk Assessment* (EPA 1992). This approach divides the ERA process into three steps: problem formulation, analysis, and risk characterization.

The goal of the problem formulation step is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA 1992). The problem formulation phase results in characterization of stressors (i.e., identification of the contaminants),

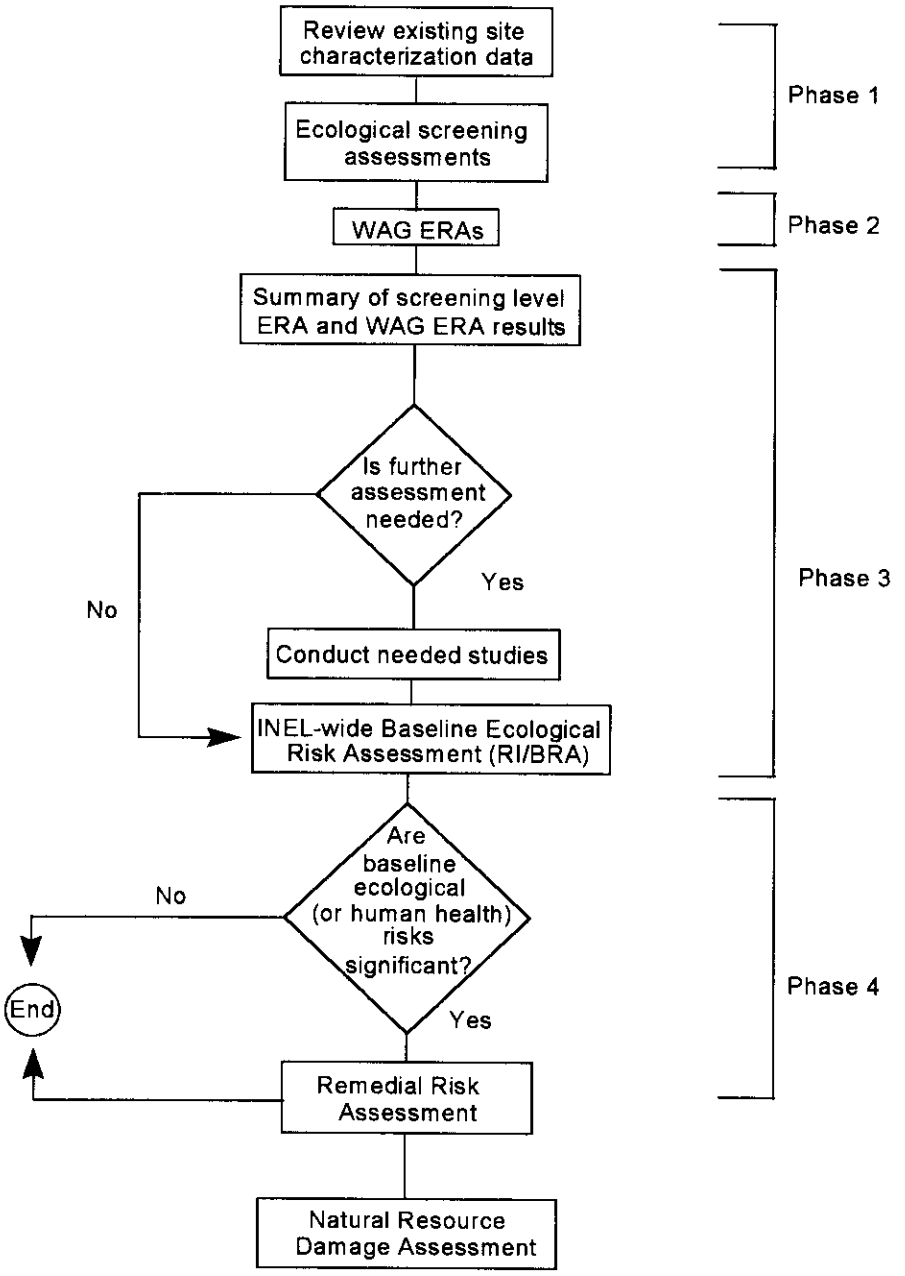

Figure 7-1. A phased approach to the INEEL ERA.

definition of assessment and measurement endpoints, and the ecological effects that will be used to analyze risk using the conceptual site model (CSM). This step of the assessment is presented in Section 7.2, WAG ERA Problem Formulation.

In the analysis step, the likelihood and significance of an adverse reaction from exposure to the stressor(s) were evaluated. The exposure assessment involves relating contaminant migration to exposure pathways for ecological receptors. The behavior and fate of the COPCs in the terrestrial environment was presented in a general manner because no formal fate and transport modeling was conducted for this WAG ERA. The ecological effects assessment consisted of hazard evaluation and dose-response assessment. The hazard evaluation involved a comprehensive review of toxicity data for contaminants to identify the nature and severity of toxic properties. Dose from multiple media (surface and subsurface soil, and surface water) identified at the INEEL were developed and used to assess potential risk to receptors. Because no dose-based toxicological criteria exist for ecological receptors, it was necessary to develop appropriate toxicity reference values (TRVs) for the contaminants and functional groups at the INEEL. A quantitative analysis was used, augmented by qualitative information and professional judgment as necessary. This step of the analysis is presented in Section 7.3, Analysis.

The risk characterization step has two primary elements (EPA 1992). The first element is the development of an indication of the likelihood of adverse effects to ecological receptors. The second element is the presentation of the assessment results in a form that serves as input to the risk management process. To determine whether there is any indication of risk due to the contaminant concentrations, exposure parameters were used to calculate dose for the key functional groups and sensitive species [threatened and/or endangered (T/E) and Category 2 (C2)]. Hazard quotients (HQs) were then calculated by dividing the calculated dose by the TRV and then used as an indicator of the potential for adverse effects. The risk characterization section of the WAG ERA is presented in Section 7.4, Risk Characterization.

The results of the WAG ERA will be integrated with assessments from other WAGs to support the INEEL-wide ERA [Operable Unit (OU) 10-04]. The strategy for using the results of the WAG 1 ERA to support the INEEL-wide ERA is discussed in Section 7.5.

7.1.1 Statutory and Regulatory Basis

The widespread application of ERAs to hazardous waste site investigations under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) began recently. In December 1988, the Environmental Protection Agency (EPA) directed that "thorough and consistent" ecological assessments should be performed at all Superfund sites (EPA 1988a). This directive was based on the language in CERCLA [as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and other statutes], mandating remediation of hazardous waste sites to protect the environment as well as human health. The National Contingency Plan requires that baseline risk assessments characterize current and potential threats to human health and the environment [40 CFR Part 300.430 (d)(4)], and specifies that environmental risk evaluations "assess threats to the environment, especially sensitive habitats and critical habitats of species protected under the Endangered Species Act" [40 CFR Part 300.430(e)(2)(1)(G)].

Section 121(d)(A) of CERCLA requires that Superfund remedial actions meet federal and state standards, requirements, criteria, and limitations that "are applicable or relevant and appropriate requirements (ARARs)." ARARs are those substantive environmental protection requirements promulgated under federal or state laws that, while not legally applicable to the circumstances at the site or

facility, address situations sufficiently similar so that their use is well suited to the particular site. ARARs applicable to the WAG 1 ERA are listed in Table 7-1. A further discussion of ARARs is included in the Guidance Manual (VanHorn et al., 1995).

Recognizing the need, DOE published *Incorporating Ecological Risk Assessment into Remedial Investigation/Feasibility Study Work Plans,* (DOE 1994), which "provides guidance to the U.S. Department of Energy staff and contractor personnel for incorporation of ecological information into environmental remediation planning and decision making at CERCLA sites." (DOE 1994).

Compliance with ARARs is a threshold requirement that a remedial or restoration activity must meet to be eligible for selection as a remedy. ARARs are either chemical-, action-, or location-specific, depending on whether the requirement is triggered by the presence or emission of a chemical, a particular action, or a vulnerable or protected location. A list of the definitions of these ARARs follows:

- Chemical-specific-Risk-based numerical values or methodologies that establish an acceptable amount of concentration of a contaminant in the ambient environment
- Action-specific-Technology or activity-based requirements for remedial or restoration actions
- Location-specific-Restrictions placed upon the concentration of hazardous substances or the conduct of activity at a given location.

Only location-specific ARARs are applicable in the WAG 1 ERA.

The WAG 1 ERA addresses issues related to all ARARs listed for WAG 1 in Table 7-1, except the Wetlands Conservation Act. This ARAR is included since, wetland habitat has appeared on maps as part of the Fish and Wildlife National Wetlands Inventory (Hampton et al. 1995). These are generally waste ponds that are generated solely due to facility activities and preliminary surveys indicate that most do not meet formal wetland classification criteria (ACOE 1987). However, if final evaluation indicates that these do meet formal designation criteria they will be evaluated based on ARAR considerations. T/E and/or sensitive species as protected by ARARs are discussed in Section 7.2.4.

Table 7-1. ARARs for the WAG ERA.

Requirement	Authority	Trigger
Endangered Species Act	16 USC 1531–1543	Location specific
Threatened Fish and Wildlife	50 CFR 227.4	Location specific
Migratory Bird Conservation	16 USC 715	Location specific
Migratory Bird Treaty Act	16 USC 702	Location specific
Protection of Bald and Golden Eagles Act	16 USC 1531	Location specific
Idaho Fish and Wildlife Act	16 USC 756, 757	Location specific
Wetlands Conservation Act	16 USC 4404	Location specific

7.2 WAG ERA Problem Formulation

The goal of the problem formulation step of the ERA is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA 1992). This process begins with a general description of the site and previous investigations, and a characterization of the ecosystem at risk. Next, the potential stressors to the ecosystem are identified, the migration pathways of the identified stressors are modeled, and the potentially affected components of the ecosystem are identified. The ecosystem at risk and stressor characterization with exposure pathways are then assimilated into the CSM. The problem formulation step results in the characterization of stressors (i.e., the identification of the COPCs), the definition of the assessment endpoints, and pathway and exposure models that are used to analyze risk using the CSM. Primary elements of the problem formulation step for the WAG ERA are described in the following sections.

7.2.1 Overview of WAG 1

TAN is located in the northeastern portion of the INEEL, about 27 miles northeast of Central Facilities Area, as shown in Figure 1-5. Contained within a radius of 2,550 m (8,370 ft) are the five Test Area North (TAN) industrial areas: Technical Support Facility (TSF), WRRTF, LOFT facility, Initial Engine Test (IET) facility, and Specific Manufacturing Capability (SMC) facility. In the 1950s, the primary purpose of this facility was to support the General Electric Aircraft Nuclear Propulsion (ANP) Program, the mission of which was to test the concept of a nuclear-powered airplane. The program was involved in the testing of three versions of a full-scale, nuclear-powered aircraft engine until 1961, when the program was canceled by Congress. From 1962 until the 1970s, the TAN Hot Shop and hot cells, support facilities for TSF, were devoted principally to the LOFT Program and miscellaneous minor examinations and tests for TRA and Power Burst Facility (PBF). Beginning in 1980, the TAN Hot Shop and hot cells supported research and development on material from the Three Mile Island Unit 2 (TMI-2) reactor as a result of the 1979 accident. During the mid-1980s, the final tests for the LOFT Program were supported by the Hot Shop.

Chemical and radioactive waste generated at the TAN facility was primarily a result of the test and evaluation programs. Additionally, the decontamination, disassembly, evaluation, and discarding of the various components of the tests resulted in the generation of a wide variety of waste. Radioactive contamination at the TAN facility typically stems from contaminated water in disposal ponds and scrap metal. Nonradioactive contaminants include metals, volatile organic compounds (VOCs), and polychlorinated biphenyls (PCBs) generally in surface or subsurface soils.

7.2.2 Sites of Concern

As discussed in the Guidance Manual (VanHorn et al. 1995) the sites identified in the FFA/CO (DOE-ID 1991) were initially eliminated from consideration in WAG 1 ERA analysis based on whether the site is uncontaminated (no source to the environment) or because the site is inaccessible to the ecosystems of concern (no pathway to the environment). All sites at WAG 1 were reviewed for possible elimination from consideration in the WAG 1 ERA. Table 7-2 includes justification for eliminating sites from consideration.

The final list of sites included in the ERA analysis (sites of concern) is presented in Table 7-3. This table lists the COPCs identified at each site, and provides a brief description and size of each site. Refer to Figure 7-2, which illustrates the locations of the individual sites of potential concern to ecological receptors at the TAN facility. More complete descriptions of the sites of concern for both

Table 7-2. WAG 1 operable unit and site descriptions.

OU	Site code	Sites description	Track[a]	IN[b]	Justification
—	IET-02	IET Burial Pit northeast of IET	NA	—	No source.
—	IET-08	IET Septic Tank (TAN-710) and Filter Bed	NA	—	No source or pathway to ecological receptors.
—	LOFT-04	LOFT Injection Well (TAN-733)	NA	—	No pathway to ecological receptors.
—	LOFT-09	LOFT Septic Tank and Drain Field (TAN-762)	NA	—	No source or pathway to ecological receptors.
—	LOFT-13	LOFT Dry Well (TAN-333) and Surficial Sediments	NA	—	No source or pathway to ecological receptors.
—	SMC-01	SMC Septic Tank and Drain Field (TAN-629)	NA	—	No source.
—	TSF-16	TSF Brine Pit North of TAN-608	NA	—	No source.
—	TSF-30	TSF Septic Tank East of TAN-602	NA	—	No source or pathway to ecological receptors.
—	WRRTF-07	WRRTF Septic Tank & Sand Filters (TAN-737)	NA	—	No source or pathway to ecological receptors.
—	TSF-40	Rubble Piles near TAN	NA	—	No source.
—	TSF-41	Scrap Yard South of WMF-613	NA	—	No source.
—	TSF-34	Fuel Oil Tank 607S	NA	—	No source. Contaminated soil was removed when tank was removed.
—	TSF-35	TSF Acid Sump Southeast of TAN-609	T1	—	All contaminated soil was removed from site when tank was removed. No source.
1-01	LOFT-15	LOFT Buried Asbestos Pit	T1	—	Former site of construction materials; debris was removed. No source.
1-01	TSF-39	TSF Transite (Asbestos) Contamination	T1	—	Asbestos material is encapsulated in cement and is not likely to be released. No other contamination is present. No source or pathway to ecological receptors.
1-01	TSF-42	TAN-607A Room 161 Contaminated Pipe	T1	—	This site is located under Building TAN-607A. Pipe is radioactively contaminated, but no pathway to ecological receptors exists. Will be handled under the D&D program for TAN-607.
1-01	TSF-43	RPSSA Buildings 647/648 Pads	T1	—	Parking pads radioactively-contaminated with fixed contamination. No pathway to ecological receptors.
1-01	IET-05	IET Foam Stabilizer Tank (TAN-317)	T1	—	Tank was removed in 1990. The biodegradable and nonhazardous fire-fighting foam the tanks contained was properly disposed. No evidence of release. No source (Lewis et al. 1996).
1-01	IET-06	IET Injection Well (TAN-332)	T1	—	Injection well has a 72.6-m (250-ft) depth. No pathway to ecological receptors exists.

Table 7-2. (continued).

OU	Site code	Sites description	Track[a]	IN[b]	Justification
1-01	LOFT-03	LOFT Rubble Pit South of LOFT Disposal Pond	T1	—	Site on construction debris disposal. All debris was removed. Field inspections and field screening during cleanup did not reveal any organic or radiological contamination. No source.
1-01	LOFT-07	LOFT Foam Solution Tank (TAN-119)	T2	—	Tank was removed in 1994. Samples from the bed of the tank excavation (>12 ft bgs) exceeded baseline concentrations for native metals (Lewis et al. 1996). No pathway to ecological receptors.
1-01	LOFT-11	LOFT Cryogen Pits (3) East of TAN-629	T1	—	Pits were never used for the intended purpose, nor were any hazardous or radioactive materials known or suspected to have been disposed here. No source.
1-01	TSF-01	TSF Diesel Tank West of TAN-607 and Fuel Spill	T1	—	All contaminated soil was removed from the site when tank was removed. No source.
1-01	TSF-04	TSF Gravel Pit/Acid Pit	T1	—	Site was to be used primarily for construction debris. Field inspection revealed no evidence of stressed vegetation or surface stains. No source.
1-01	TSF-11	TSF Three Clarifier Pits East of TAN-604	T1	—	This site remediated, by removal and excavation to 7 ft bgs. Sampling indicates low levels of organics and Am-241. All are below EBSLs.
1-02	IET-01	IET Gasoline Storage Tank (TAN-318)	T1	—	Tank was removed. Field sampling results indicated no organic contamination present. Based on laboratory and visual observations there is no evidence of residual contamination. No source (Lewis et al. 1996)
1-02	IET-09	IET Lube Oil Tank (TAN-316)	T1	—	Tank was removed in 1991. No source. Based on laboratory and visual observations, there is no evidence of residual contamination (Lewis et al. 1996).
1-02	IET-10	IET Diesel Fuel Tank (TAN-316)	T1	—	Tank was removed. Some contaminants remain at greater than 6 m (20 ft) bgs. No pathway to ecological receptors (Lewis et al. 1996).
1-02	IET-11	IET Heating Oil Tank	T1	—	Tank was removed. Some contaminants remain at greater than 6 m (20 ft) bgs. No pathway to ecological receptors (Lewis et al. 1996).
1-02	LOFT-05	LOFT Two Fuel Tanks (TAN-109 A and B)	T1	—	Tanks are empty and in place for possible future use. No records of spills or leaks. No source (Lewis et al. 1996).
1-02	LOFT-06	LOFT Slop Tank East of TAN-631	T1	—	Tank is filled with sand. No releases are known to have occurred. Area is covered by asphalt road and parking lot (Lewis et al. 1996). No source or pathway to ecological receptors.

Table 7-2. (continued).

OU	Site code	Sites description	Track[a]	IN[b]	Justification
1-02	LOFT-08	LOFT Tank in Borrow Pits (TAN-110)	T1	—	Tank removed in 1991, low levels of contaminants remain at 22 ft bgs (Track 1). No pathway to ecological receptors.
1-02	TSF-13	TSF Gasoline Tank North of TAN-610	T1	—	Tank was removed. No releases have been recorded. A soil boring detected no organic vapors; no stained soil was observed. No source (Lewis et al. 1996).
1-02	TSF-14	TSF Fuel Oil Tank Northwest of TAN-603	T1	—	Tank was removed. All contaminated soil was removed from the site when tank was removed. Contamination remains at 3.6 m (12 ft) bgs. No pathway to ecological receptors (Lewis et al. 1996).
1-02	TSF-15	TSF Fuel Oil Tank West of TAN-603	T1	—	Tank was removed and excavated to 9 ft bgs. Organics detected at that level are below EBSLs. No pathway to ecological receptors.
1-02	TSF-24	TSF Oil Sumps (TAN-609)	T1	—	All contaminated soil was removed from site when tank was removed. No source remains (Lewis et al. 1996).
1-02	TSF-25	Underground Drain Sump East of TAN-609	T1	—	Formerly contained waste jet fuel. Field sampling results indicated contamination present at a depth greater than 3 m (10 ft). No pathway to ecological receptors.
1-02	TSF-32	TSF Oil Tank South of TAN-601 (Between Gatehouse and Substation)	T1	—	Tank appears to have been removed between late 50s and 1967. No residual contamination detected. Site currently covered by asphalt road and parking lot. No source or pathway to ecological receptors (Track 1).
1-02	TSF-33	TSF T-11 Fuel Tank East of TAN-602	T1	—	Tank removed in 1990. No leaks or contamination detected (Lewis et al. 1996). No source.
1-02	WRRTF-09	WRRTF Diesel Fuel Tank (TAN-103)	T1	—	Tank was removed in 1990 and contaminated soil removed. Field sampling results indicated contamination present in the 4.5-m (15-ft) tank excavation. No pathway to ecological receptors (Lewis et al. 1996).
1-02	WRRTF-10	WRRTF Gasoline Tank (TAN-644)	T1	—	Tank was removed. Field sampling results indicated contamination present at least 3.0 m (10 ft) bgs. No pathway to ecological receptors (Lewis et al. 1996).
1-02	WRRTF-12	WRRTF Diesel Fuel Tank (TAN-1714)	T1	—	Tank was removed. All contaminated soil was removed to a depth of 5.4 m (18 ft) (Lewis et al. 1996). No pathway to ecological receptors.
1-03	TSF-02	TSF Service Station Spill (TAN-664)	T2	—	Site of a gasoline spill approximately 10 years ago. Given the volume and nature of the contaminants, it is likely that contamination has been volatilized or degraded, subsequently, the service station roadbed replacement upgrade essentially moved the source of contamination at this site (Lewis et al. 1996).

Table 7-2. (continued).

OU	Site code	Sites description	Track[a]	IN[b]	Justification
1-03	TSF-03	TSF Burn Pits	T2	X	—
1-03	TSF-38	TSF Bottle Site	T2	-	This site was remediated by excavation to 4 ft in the summer of 1994. Organic compounds detected were below EBSLs and metals (Be, Mg, and Ca) were less than 1% above surface background (Lewis et al. 1996).
1-03	WRRTF-01	WRRTF Burn Pit	T2	X	—
1-04	LOFT-02	LOFT Disposal Pond (TAN-750)	T2	X	—
1-04	TSF-12	TSF Acid Neutralization Sump North of TAN-602	T2	—	Site is beneath the building. There were no reports that either sump had leaked or overflowed (Lewis et al. 1996). No pathway to ecological receptors.
1-04	TSF-17	TSF Two Neutralization Pits North of TAN-649	T2	—	Pits were removed. There is no evidence of a leak or spill at this site. No contamination remains (Lewis et al. 1996). No source.
1-04	TSF-19	TSF Caustics Tank V-4 South of TAN-616	T2	—	Tanks abandoned in place. The tank is buried 3 m (10 ft) bgs and partially beneath a building (Lewis et al. 1996). No source or pathway to ecological receptors.
1-04	TSF-20	TSF Two Neutralization Pits North of TAN-607	T2	-	The pits were removed in 1993. TSF-20 tank was never reported to have leaked or overflowed. No contamination detected at the ground surface around the tank. Radiological contamination in soil below tanks was <1 pCi/g and/or below background (Lewis et al. 1996). No source.
1-04	TSF-29	TSF Acid Pond (TAN-735)	T2	X	—
1-04	TSF-31	TSF Acid Pit West of TAN-647	T2	—	No evidence of waste disposal or contamination present at this site (Lewis et al. 1996). No source.
1-05	IET-04	IET Stack Rubble Site	T2	—	Site contains buried radioactive debris at 3.0 to 4.6 m (10 to 15 ft). No pathway to ecological receptors.
1-05	IET-07	IET Hot Waste Tank (TAN-319)	T2	—	Tanks were removed. No contamination evident in the 6-m (20-ft) deep tank excavation (Lewis et al. 1996). No source or pathway to ecological receptors.
1-05	TSF-06	TSF TAN/TSF-1 Soil Area	T2	X	—
1-05	TSF-09	TSF Intermediate-Level (Radiation) Waste Disposal System	T2	X	-
1-05	TSF-10	TSF Drainage Pond (TAN-782)	T2	X	—
1-05	TSF-18	TSF Contaminated Tank Southeast of Tank V3	T2	X	

Table 7-2. (continued).

OU	Site code	Sites description	Track[a]	IN[b]	Justification
1-05	TSF-21	TSF/IET Valve Pit	T2	—	Valve pit was removed. Mixed waste soil contamination remains; however, no contamination above 3 m (10 ft) (Lewis et al. 1996). No pathway to ecological receptors.
1-05	TSF-26	TSF PM-2A Tanks (TAN-710 A and B)	T2	X	—
1-05	WRRTF-04	WRRTF Radioactive Liquid Waste Tank (TAN-735)	T2	—	Tank was removed and excavated to 6.1 m (20 ft). No pathway to ecological receptors (Lewis et al. 1996).
1-06	LOFT-01	LOFT Diesel Fuel Spills (TAN-629)	T1	—	Contaminated soil was removed. Field sampling indicated contamination present only in soil from 3.0 to 9.0 m (10 to 30 ft) bgs (Lewis et al. 1996). No pathway to ecological receptors.
1-06	LOFT-10	LOFT Sulfuric Acid Spill (TAN-771)	T1	—	Acids disposed of in LOFT ponds (LOFT-02 or TAN-650) were assumed neutralized. Contaminated soil was disposed. No source (Lewis et al. 1996).
1-06	TSF-07	TSF Disposal Pond	T1	X	—
1-06	TSF-08	TSF HTRE III Mercury Spill Area	T2	X	—
1-07A 1-07B	TSF-05	TSF Injection Well	IA RI/FS	—	There is no surface contamination. No pathway to ecological receptors.
1-07A 1-07B	TSF-23	TSF Drinking Water Potential Contamination	IA RI/FS	—	No pathway to ecological receptors.
1-08	WRRTF-13	WRRTF Fuel Oil Leak	T2	X	—
1-08	TSF-22	TSF Railroad Turntable	T2	X	—
1-08	TSF-28	TSF Sewage Treatment Plant (TAN-623) and Sludge Dry Beds	T2	—	Sludge was removed and disposed in 1990 and 1992. The dry beds were sampled in 1993. Co-60 and Cs-137 were detected (Lewis et al. 1996). The levels for these radionuclides are below EBSLs.
1-08	WRRTF-05	WRRTF Injection Well (TAN-331)	T2	—	Possible groundwater contamination. No pathway to ecological receptors.
1-09	TSF-36	TAN-603 French Drain	T1	X	—
1-09	TSF-37	TSF Contaminated Well Water Spill	T2	X	—
1-09	WRRTF-02	WRRTF Two-Phase Pond (TAN-763)	T1	—	This unlined surface impoundment received steam condensate and process wastewater containing demineralization or corrosion-inhibiting solutions; however, it is believed these solutions neutralized. This site was not sampled. Process knowledge was used to determine that this site has not been contaminated. No source (Lewis et al. 1996). (Track 1).
1-09	WRRTF-03	WRRTF Evaporation Pond (TAN-762)	T1	X	—

Table 7-2. (continued).

OU	Site code	Sites description	Track[a]	IN[b]	Justification
1-09	WRRTF-06	WRRTF Sewage Lagoon	T1	—	This unlined surface impoundment received nonhazardous sanitary and process waste only, and it is believed these products were biodegraded or neutralized. No soil samples have been collected from the area, however, waste water samples collected from November 1985 to September 1986 were used to estimate soil concentrations for risk assessment at this site. All estimated levels would add less than 1% to background. Silver was also detected but estimated concentration in soil is below EBSLs (Track 1).
1-10	LOFT-12	LOFT XFMR Yard #2 PCB Spill	T1	X	—
1-10	LOFT-16	LOFT Landfill Northeast of LOFT-02 Drainage Pond	T1	—	Historically this site was used to dispose of excess construction materials and equipment. In 1994 this site was assessed. Field surveys indicate that no contamination from mercury or radiation is present at this site. Analytical results confirm that only very low to insignificant levels of contamination from VOCs are present at the landfill (Lewis et al. 1996).
1-10	TSF-27	TSF Paint Shop Floor Drain Leach Field (West of TAN-636)	RI	—	Field sampling indicates contamination present above background levels at 11 to 30 ft bgs (Lewis et al. 1996). No pathway to ecological receptors.
1-10	TSF-44	TSF Diesel Fuel Pipeline Leak Northwest of TAN-604	T1	—	All visible contaminated soil and oils were removed during the time of the leaks. No source (Lewis et al. 1996). Releases below 9.0 m (30 ft) bgs. No pathway to ecological receptors.
1-10	TSF-45	TSF Buried Construction Debris near the TAN Gravel Pit	T1	—	Historical information and process knowledge indicate no hazardous or radioactive materials disposed of here. This was used for construction waste that was buried 4.8 to 6.0 m (16 to 20 ft) bgs. No source.
1-10	—	IET Pond and Ditch West of IET	—	—	—
1-10	—	IET Gravel Pit	—	—	—
1-10	—	IET Burn Pit East of IET	—	—	—
1-10	—	LOFT Burn Pit Northwest of LOFT	—	—	—
1-10	—	TSF Burn Pit II Southwest of the TSF-05 Injection Well	—	—	—
1-10	—	TSF radioactive spills on Bear Blvd. West of TAN-607	—	—	—
1-10	—	Radioactive Spill 1 mi. South of TAN on Lincoln Blvd.	—	—	—
1-10	—	Sand Piles South of TSF and Southwest of WRRTF	—	—	—

Table 7-2. (continued).

OU	Site code	Sites description	Track[a]	IN[b]	Justification
1-10	--	WRRTF Transite Area	--	--	--
1-10	--	Broken Pipe in Bern of TAN-633	--	--	--
1-10	--	Buried asbestos behind the hangar at SMC	--	--	--

a. Stage in CERCLA process as follows: NA = no action—initial investigation determined sites were uncontaminated and no source present, T1 = Track 1; T2 = Track 2; IA = Interim Action; RI = Remedial Investigation/Feasibility Study (RI/FS).

b. Sites marked with "X" were not screened out in the initial site review.

c. EBSLs = ecological based screening levels.

Table 7-3. WAG 1 operable units and sites of concern.

OU	Site code	Site description	Site (m^2)	COPCs	Contaminated medium	Comments
1-03	TSF-03	TSF Burn Pits	155	Lead, VOCs	Subsurface	EGG-ER-10554
1-03	WRRTF-01	WRRTF Burn Pits	2,520	Radionuclides, metals, VOCs	Subsurface	EGG-ER-10554
1-04	LOFT-02	LOFT Disposal Pond (TAN-750)	10,000	Metals	Surface -sediment, subsurface, water	EGG-ER-11090
1-04	TSF-29	TSF Acid Pond (TAN-735)	88	Radionuclides	Surface, subsurface soil	EGG-ER-11090
1-05	TSF-06	TAN/TSF-1 Soil Area	18,600	Radionuclides	Surface, subsurface soil	Site consists of numerous subareas of radioactive soil. EGG-ER-11162
1-05	TSF-09	TSF Intermediate-Level (Radiation) Waste Disposal	370	Radionuclides	Subsurface soil	EGG-ER-11162
1-05	TSF-10	TSF Drainage Pond (TAN-782)	2,600	Cs-137, manganese	Surface-sediment, subsurface, water	EGG-ER-11162
1-05	TSF-18	TSF Contaminated Tank southeast of Tank V3	14	Radionuclides	Surface, subsurface soil	EGG-ER-11162
1-05	TSF-26	TSF PM-2A Tanks (TAN-710 A and B)	650	Cs-137, Co-60	Surface, subsurface soil	EGG-ER-11162
1-06	TSF-07	TSF Disposal Pond	9,800	Radionuclides, metals, PCBs, VOCs	Surface-sediment, subsurface, water	This pond is included in the OU 1-10 RI
1-06	TSF-08	TSF HTRE III Mercury Spill Area	90	Cs-137. Co-60, mercury	Subsurface soil	—
1-08	WRRTF-13	WRRTF Fuel Oil Leak	125	VOCs	Subsurface soil	—
1-08	TSF-22	TSF Railroad Turntable	590	Cs-137, mercury	Surface and subsurface soil	—
1-09	TSF-36	TAN-603 French Drain	7.3	Benzo(a)pyrene	Subsurface soil	Drain is 2.7 m (9 ft) deep. No hazardous or radioactive materials are known to have been disposed of. Results of soil sample analyses taken from the sump base detected benzo(a)pyrene, 1994 removal action. (EGG-ER-11263)
1-09	TSF-37	TSF Contaminated Well Water Spill	7.3	Sr-90, H-3	Subsurface soil	—
1-09	WRRTF-03	WRRTF Evaporation Pond (TAN-762)	5,574	Metals	Surface and subsurface soil	—
1-10	LOFT-12	LOFT North Transformer Yard PCB Spill and Soil Site	166.5	PCB	Surface and subsurface soil	—

human and ecological health are presented in Section 3. Additionally, two sites (LOFT-02 and WRRTF-03) that were previously eliminated as presenting no risk to human health were assessed for ecological receptors. The sites retained for assessment in the ERA are described here.

- **LOFT-02**—The LOFT disposal pond (TAN-750) (LOFT-02) is an active disposal (or seepage) pond located approximately 210 m (700 ft) north of the LOFT hangar, Building TAN-629. The pond was constructed in 1971 to receive wastewater form the operations associated with the LOFT experiments. The wastewater consisted primarily of once-through cooling water from air compressors and generators at the LOFT facility from 1975 to 1986. The pond currently is being used by the SMC operations for disposal of sanitary wastewater and boiler blowdown liquid. Soil sample results at LOFT-02 have indicated that TAN baseline concentrations for aluminum, beryllium, copper, magnesium, manganese, and vanadium have been exceeded. Soil, sediment, and water samples that were collected in 1989 from the LOFT disposal pond provided the concentrations used for the WAG 1 ERA. This site is believed to be contaminated with metals in both the surface and subsurface soils. The concentrations were found to be below risk-based levels for human health. A comparison of the sample results with EBSLs indicated that this site should be retained for evaluation in the WAG 1 ERA.

- **WRRTF-03**—WRRTF-03 is the site of an unlined evaporation pond that was constructed during the summer of 1984 to replace the WRRTF-05 injection well that collapsed on March 30, 1984. The pond has been used to dispose of process wastes from the TAN-640, TAN-641, TAN-645, and TAN-646 buildings at WRRTF.

  The pond is still in use; however, existing flows are very small. The pond is located approximately 300 ft south of TAN-645 and consists of two cells separated by a 3- to 4-ft tall berm. The main cell is approximately 300 ft × 200 ft in size, less a 120-ft × 55-ft section in the northwest corner, which is the WRRTF-06 sewage lagoon.

  No data exist on the quantity of wastewater discharged to the pond; however, using available data on the WRRTF-05 injection well [INEEL Industrial Non-radioactive Waste Management Information System (INWMIS) database], a volume of 2.4 million gal/mon from late 1984 to 1992, or 230 million gal, was estimated.

  No soil samples have been collected from the pond, but the wastewaters have been sampled as described below. Wastewater discharged to the pond was sampled 36 times from November 1985 to September 1986. Grab samples were collected two to three times on each of the 12 days. Samples were analyzed for pH, conductivity, anions, total organic carbon (TOC), total organic halogens (TOX), and metals. No unexpected results occurred. TOX levels were low, indicating that hazardous organic compounds were not discharged regularly to the pond. Chlorides, nitrates, phosphates, and sulfates, barium, cadmium, chromium, lead, and silver were detected in the wastewater. Estimated concentrations of some of the contaminants in the pond soils based on the cumulative impact of wastewater discharged to the pond are above background.

7.2.3 Ecosystem Characterization

INEEL is located in a cool desert ecosystem characterized by shrub-steppe vegetative communities typical of the northern Great Basin and Columbia Plateau region. The surface of INEEL is relatively flat, with several prominent volcanic buttes and numerous basalt flows that provide important habitat for small and large mammals, reptiles, and some raptors. The shrub-steppe communities are dominated by

sagebrush *(Artemisia* spp.) and provide habitat for sagebrush community species such as sage grouse *(Centrocercus urophasianus),* pronghorn *(Antilocapra americana),* and sage sparrows *(Amphispiza belli).* Other communities are comprised of rabbitbrush *(Chrysothamnus* spp.), grasses and forbs, salt desert shrubs *(Atriplex* spp.), and exotic or weed species. Juniper woodlands occur near the buttes and in the northwest portion of INEEL; these woodlands provide important habitat for raptors and large mammals. Limited riparian communities exist along intermittently flowing waters of the Big Lost River and Birch Creek drainages.

WAG 1, which is comprised of hazardous waste release sites at the TAN, is located in the north-central portion of the INEEL (refer to Figure 1-5). TAN is an industrial facility with most land surfaces covered by disturbed, bare ground or facilities and pavement. Natural areas are limited to those areas outside the perimeter of WAG 1. Figure 7-2 illustrates vegetation communities and soil types associated with TAN and the surrounding areas. Areas outside the WAG 1 fenced boundary include sagebrush/rabbitbrush shrub-steppe, sagebrush-steppe on lava, and grasslands. These components are discussed in detail in the following sections.

7.2.4 Biotic Components

Wildlife species present in and around TAN include birds, mammals, and reptiles that are associated with facilities, sagebrush-rabbitbrush, grasslands, and salt desert shrub habitats, deciduous trees and shrubs, and water (e.g., facility ponds and drainage areas). Both aquatic and terrestrial species are potentially present. Sagebrush-rabbitbrush and salt desert shrubs habitats support a number of species including sage grouse and pronghorn (important game species). Grasslands provide habitat for species such as the western meadowlark *(Sturnella neglecta)* and mule deer (also a game species). Buildings, lawns and ornamental vegetation, and disposal/drainage ponds at WAG 1 are utilized by a number of species such as waterfowl, raptors, rabbits, and bats. No areas of critical habitat as defined in the Code of Federal Regulations (40 CFR Part 300) are known to exist in or around TAN.

The flora and fauna existing around the TAN facility are representative of those found across the INEEL (Arthur et al. 1984; Reynolds et al. 1986) and are described in the following sections. Flora surrounding TAN was determined using a vegetation map constructed for the INEEL using LANDSAT imagery and field measurements from vegetation plots (Kramber et al. 1992). Fauna potentially existing in the TAN area was identified primarily from a 1986 vertebrate survey performed on the INEEL (Reynolds et al. 1986) and from data collected subsequent to the survey. While the flora and fauna present at TAN have not been verified with a comprehensive field survey, information presented here is supported by previous field surveys and observations as described in Appendix E.

7.2.4.1 Flora. The 15 INEEL vegetation cover classes defined using LANDSAT imagery data (Kramber et al. 1992) have been combined into eight cover classes for the WAGs (VanHorn et al. 1995). The vegetation surrounding TAN shown in Figure 7-2 represents six vegetation cover classes, including sagebrush-rabbitbrush, grassland, salt desert shrub, playa-bareground/disturbed areas, sagebrush-steppe on lava, and wetlands. The species composition for each of these classes is summarized on Table 7-4. Sagebrush/rabbitbrush is the predominant vegetation type. The dominant vegetation species within this community are the Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and green rabbitbrush (*Chrysothamnus viscidiflorus*). Grasslands present in the area consist primarily of wheat grasses (*Agropyron* spp. and *Elymus* spp.). Wetland species are supported by intermittent standing water from facility drainage and disposal ponds. The waste pond associated with the LOFT facility is still used for facility wastewater and a portion of the pond has been mapped by the National Wetlands Inventory. The playa-bareground/disturbed cover class represents extensive playa areas associated with the Big Lost River and Birch Creek historical drainages.

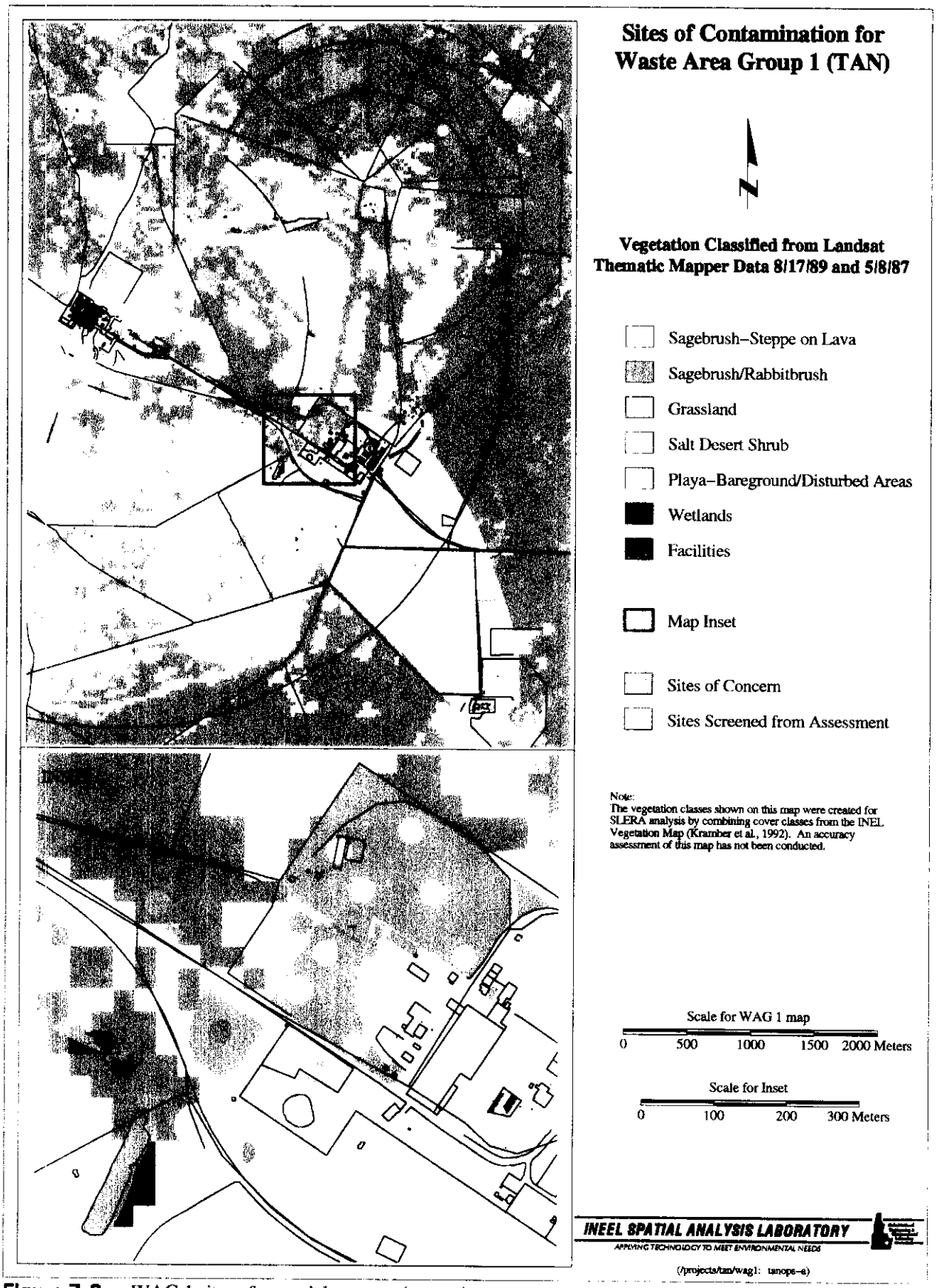

Figure 7-2. WAG 1 sites of potential concern (orange).

Table 7-4. Vegetation cover class summary for WAG 1 area.

WAG ERA Vegetation cover class	INEEL vegetation cover classes	Dominant species
Grasslands	Steppe Basin wildrye Grassland	*Leymus cinereus* *Descurainia sophia* *Sisymbrium altissimum* *Elymus lanceolatum* *Artemisia tridentata* ssp. *wyomingensis* *Elymus elymoides* *Chrysothamnus viscidiflorus*
Sagebrush-rabbitbrush	Sagebrush-steppe off lava Sagebrush-winterfat Sagebrush-rabbitbrush	*Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus* *Bromus tectorum* *Sisymbrium altissimum* *Achnatherum hymenoides*
Sagebrush-steppe on lava	Sagebrush-steppe on lava	*Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus* *Achnatherum hymenoides*
Salt desert shrub	Salt desert shrub	*Atriplex nutallii* *Atriplex canescens* *Kraschennikovia lanata*
Wetlands	Wetlands	*Eleocharis palustris* *Typha latifolia* *Pascopyrum smithii*
Playa-bareground/disturbed areas	Playa-bareground/gravel borrow pits Old fields, disturbed areas, seedings	*Kochia scoparia* *Salsola kali* *Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus*

7.2.4.2 Fauna. A comprehensive list of fauna potentially present at and surrounding TAN is presented in Appendix F. The list incorporates the concept of functional grouping as described in detail in Appendix E (Hampton and Morris 1995) of the Guidance Manual (VanHorn et al. 1995). The functional grouping approach is designed to group similar species to aid in analyzing the effects of stressors on INEEL ecosystem components. The primary purpose for functional grouping is to apply existing data from one or more species within the group to assess the risk to the group as a whole. Functional groups are used to perform a limited evaluation of exposures for all potential receptors and provide a mechanism for focusing subsequent analyses on receptors that best characterize potential contaminant effects.

Functional groups designed to be representative of receptors at WAG 1 have been identified from those listed in Appendix F. The functional groups evaluated in the WAG 1 ERA were selected with the assumption that those groups would be conservative indicators of effect for other similar groups. Species characteristics including trophic level, breeding, and feeding locations were used to construct functional groups for INEEL species. Individual groups were assigned a unique identifier consisting of a one- or two-

letter code to indicate taxon (A = amphibians, AV = birds, M = mammals, R = reptiles, I = insects), and a three-digit code derived from the combination of trophic category and feeding habitats. For example, AV122 represents the group of seed-eating (herbivorous) bird species whose feeding habitat is the terrestrial surface and/or understory. The trophic categories (first digit in three-digit code) are as follows: 1 = herbivore, 2 = insectivore, 3 = carnivore, 4 = omnivore, and 5 = detrivore. The feeding habitat codes (second and third digits in three-digit code) are derived as follows:

1.0 Air

2.0 Terrestrial

- 2.1 Vegetation canopy
- 2.2 Surface/understory
- 2.3 Subsurface
- 2.4 Vertical habitat (man-made structures, cliffs, etc.)

3.0 Terrestrial/Aquatic Interface

- 3.1 Vegetation canopy
- 3.2 Surface/understory
- 3.3 Subsurface

3.4 Vertical habitat

4.0 Aquatic

- 4.1 Surface water
- 4.2 Water column
- 4.3 Bottom

The list of species potentially present in the vicinity of WAG 1 was developed by updating 1986 data on the relative abundance, habitat use, and seasonal presence of fish, amphibians, reptiles, birds, and mammals recorded on the INEEL (Reynolds et al. 1986) and by communicating with INEEL researchers and personnel conducting ecological studies since 1986. Fauna that are not supported by the existing habitat or that are rare or uncommon or otherwise unlikely to be found in the TAN area were not included in the literature search for species specific exposure and/or toxicity data. Those species are also listed in Appendix F.

Use of the LOFT disposal pond (LOFT-02) and the TSF disposal pond (TSF-07) by wildlife has been documented in the report by Cieminski (1993), *Wildlife Use of Wastewater Ponds at the INEL*. A complete list of species observed at the disposal ponds and their frequency of use is provided in the Cieminski (1993) report. The LOFT pond is a 3-acre active disposal (or seepage) pond which currently is being used by the SMC operations for disposal of sanitary wastewater and boiler blowdown liquid. TSF-07 is an unlined disposal pond. The active portion of the pond is 1.5 acres in size. These ponds are known to be frequented by waterfowl, including ducks, geese, mergansers, and scaup; shorebirds, including avocet, sandpipers, killdeer, willet, phalarope, coots, and grebe; swallows; and passerines including blackbirds, sparrows, starlings, horned lark, and doves; and, to a limited extent, by raptors such as kestrel, ferruginous hawk, and northern harrier (Cieminski 1993). Mammals have also been observed at the disposal ponds despite their being fenced. Species observed include coyote, muskrat, and pronghorn (Cieminski 1993).

Species potentially present at and surrounding WAG 1 represent all 23 INEEL avian functional groups and nine of 10 mammalian functional groups. Both reptilian functional groups are represented by

species inhabiting the immediate area. No amphibians are known to be present and no surface hydrology exists to support fish. Aquatic invertebrates, however, are supported by habitat provided by facility disposal and drainage ponds (Cieminski 1993).

Both aquatic and terrestrial invertebrates and microorganisms are present at TAN. Invertebrates are important links in dietary exposure for wildlife, and also may function as good indicators for contaminant exposure in soil, aquatic systems, and vegetation uptake, and microorganisms also play an important role in ecosystem processes. A list of terrestrial invertebrates potentially present in and surrounding TAN is not currently available and these ecosystem components will not be assessed in the WAG 1 ERA.

Although some population studies have been conducted for cyclic rabbit and rodent populations and several game species (e.g., pronghorn, sagegrouse, and raptors), no recent comprehensive studies have been conducted to assess either WAG-specific or INEEL-wide wildlife population status and trends associated with contaminant effects.

Wildlife species present in and around TAN include birds, mammals, and reptiles that are associated with facilities, sagebrush/rabbitbrush, salt desert shrub, and grassland habitats, deciduous trees and shrubs, grasslands, and water (e.g., facility ponds and drainage areas). Both aquatic and terrestrial species are potentially present. The varying behaviors of these species include, but are not limited to, grazing and browsing on vegetation, burrowing and flying, and preying on insects and small mammals. The complexity of these behaviors is significant when considering the fate and transport of contaminants and the possibility of exposure to contaminants. Subsurface contamination can become surface contamination when translocated by burrowing animals, or can be introduced into the food web when plants uptake contamination and are then ingested by an herbivore. If prey, such as a small mammal, becomes contaminated by ingesting contaminated soil or vegetation, and is then captured by a predator, such as a ferruginous hawk, the contamination can be taken offsite when the hawk returns to its nest to feed nestlings. Scenarios for potential exposure of fauna to WAG 1 contaminants are discussed in Section 7.3.

The flora and fauna present in and around TAN have been combined into a simplified food web model. Variability in environmental conditions such as population sizes or seasons is not considered in this model, and a constant environment is assumed. Because both aquatic and terrestrial habitats are present at TAN, the CSM was developed to incorporate both terrestrial and aquatic species, including the decomposers, producers (vegetation), primary consumers or herbivores (e.g., rodents), secondary consumers or carnivores (e.g., snakes), and tertiary or top carnivores (e.g., raptors). The dietary relationships between each level were simplified to assess direct and indirect exposure to contaminants as discussed later in this section.

7.2.4.3 Threatened, Endangered, or Sensitive Species. A list of T/E and sensitive species was compiled from the U.S. Fish and Wildlife Service (USFWS) (letter dated April 30, 1996), the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (CDC 1994); and RESL documentation for the INEEL (Reynolds 1994; Reynolds et al. 1986). At the time the WAG 1 SLERA was conducted, Oxytheca (Oxytheca dendroidea) was listed as a sensitive plant species with the U.S. Bureau of Land Management (BLM) and the Idaho Native Plant Society (INPS)/Idaho Fish and Game Conservation Data Center. This species has since been determined to occur in greater abundance than originally believed and has been dropped from the INPS and BLM lists (CDC 1996). No T/E plant species have been recorded in and surrounding TAN. However, an Idaho Native Plant Society (INPS) monitor species, painted milkvetch (Astragalus ceramicus var. apus), has been recorded. This species has recently been removed from the federal list of species being considered for T/E listing (CDC 1994).

T/E or sensitive species that may be found on the INEEL are listed in Table 7-5. Those with a potential for occurrence in the vicinity of WAG 1 include six terrestrial avian species: the ferruginous hawk (*Buteo regalis*), the peregrine falcon (*Falco peregrinus*), the northern goshawk (*Accipiter gentilis*), the loggerhead shrike (*Lanius ludovicianus*), the burrowing owl (*Athene cunicularia*), and the bald eagle (*Haliaeetus leucocephalus*); and four aquatic avian species: the white-faced ibis (*Plegadis chihi*), the black tern (*Childonias niger*), the trumpeter swan (*Cygnus buccinator*), and the long-billed curlew (*Numenius americanus*). Four sensitive mammal species potentially exist in the vicinity of WAG 1; these are the pygmy rabbit (*Brachylagus idahoensis*), Townsend's western big-eared bat (*Plecotus townsendii*), long-eared myotis *(Myotis evotis)*, and small-footed myotis (*Myotis subulatus*). The sagebrush lizard (*Sceloporous graciosus*) is the only sensitive reptile species with a potential presence at WAG 1. The bald eagle and peregrine falcon are federally listed species. All these species are State or Federal species of special concern (formerly C2). No critical habitat is known to exist in the WAG 1 assessment area. Because potential risks associated with contaminant exposures for T/E and species of special concern are of interest for both individuals and populations, those species most likely to contact WAG 1 sites and contaminants of concern have been evaluated for individual exposures. Other species considered very rare INEEL-wide (see Table F-2) and considered unlikely to receive chronic doses through frequenting WAG 1 and surrounding areas are represented through evaluation of the functional group with which they are associated.

Species of concern that were individually evaluated for exposure to contaminants at WAG 1 are listed in boldface text in Table 7-5. These include the bald eagle, burrowing owl, loggerhead shrike, ferruginous hawk, pygmy rabbit, and sagebrush lizard for direct and indirect exposure to soil contaminants; and the long-eared myotis, Townsend's western big-eared bat, small-footed myotis, trumpeter swan, black tern, and white-faced ibis for direct and indirect exposure to contaminants in surface water.

Breeding bird surveys (BBS) have been conducted by the Environmental Science and Research Foundation in habitats surrounding WAG 1 on the INEEL from 1985 through the present. The BBS survey route around WAG 1 is 19.2 km long with 60 stops. Stops were 0.32 km apart. The habitat along the route is described by the BBS surveyors (Belthoff et al. Submitted) as 40% big sagebrush (*Artemisia tridentata*), winterfat (*Kraschennikovia lanata*), and green rabbitbrush (*Chrysothamnus viscidiflorus*); 15% Indian rice-grass (*Achnatherum hymenoides*), green rabbitbrush, and prickly pear (*Opuntia polyacantha*); and 40% saltbush (*Atriplex nuttallii*), winterfat, and Indian rice-grass. Results of the BBSs for the period 1985–1991 were reported by Beltoff et al. (Submitted). These data, and those from subsequent years through 1996, were used to provide an assessment of whether nine species of special concern have inhabited the area surrounding WAG 1 provide a basis for an inference about their continued use of the area. The birds of interest were the trumpeter swan, black tern, loggerhead shrike, long-billed curlew, bald eagle, peregrine falcon, ferruginous hawk, northern goshawk, and burrowing owl.

Additional surveys were conducted during the summer of 1996 to determine the status of T/E and C2 species in and around the INEEL facilities (NLH-08-96). These are still in draft form, but the preliminary results are discussed here.

7.2.4.3.1 Bald Eagle—The bald eagle is federally listed, threatened and has been observed in small numbers on the INEEL (Craig 1979; Hanson 1994). Wintering populations also congregate in areas adjacent to the INEEL northern boundaries and may be particularly concentrated during years in which black-tailed jackrabbit populations are high. There is, therefore, some potential for bald eagles to prey on jackrabbits exposed at WAG 1 sites of contamination.

Table 7-5. Threatened and endangered species, special species of concern, and sensitive species that may be found on the INEEL.[a] Species in **bold** are those T/E and C2 species included for WAG 1 ERA.

		Regulatory status				
Common name	Scientific name	Federal status[b,c]	State status[c]	BLM status[c]	USFS[d] status[c]	INPS status[c]
Plants						
Lemhi milkvetch	*Astragalus aquilonius*	—	—	S	S	M
Painted milkvetch[e]	*Astragalus ceramicus var. apis*	3c	—	—	—	M
Plains milkvetch	*Astragalus gilviflorus*	NL	—	S	S	1
Winged-seed evening primrose	*Camissonia pterosperma*	NL	—	S	—	S
Nipple cactus[e]	*Coryphantha missouriensis*	NL	—	—	—	R
Spreading gilia	*Ipomopsis (Gilia) polycladon*	NL	—	S	—	2
King's bladderpod	*Lesquerella kingii* var. *cobrensis*	—	—	—	—	M
Tree-like oxytheca[e]	*Oxytheca dendroidea*	NL	—	R	—	R
Inconspicuous phacelia[f]	*Phacelia inconspicua*	C2	SSC	S	S	—
Puzzling Halimolobos	*Halimolobos perplexa* var. *perplexa*	—	—	—	S	M
Ute's ladies tresses[f]	*Spiranthes diluvialis*	LT	—	—	—	—
Birds						
Peregrine falcon	*Falco peregrinus*	LE	E	—	—	NA
Merlin	*Falco columbarius*	NL	—	S	—	NA
Gyrfalcon	*Falco rusticolus*	NL	SSC	S	—	NA
Bald eagle	***Haliaeetus leucocephalus***	**LT**	**T**	**—**	**—**	**NA**
Ferruginous hawk	***Buteo regalis***	**C2**	**SSC**	**S**	**—**	
Black tern	***Chlidonias niger***	**C2**	**—**	**—**	**—**	**NA**
Northern pygmy owl[f]	*Glaucidium gnoma*	—	SSC	—	—	NA
Burrowing owl	***Athene cunicularia***	**C2**	**—**	**S**	**—**	
Common loon	*Gavia immer*	—	SSC	—	—	NA
American white pelican	*Pelicanus erythrorhynchos*	—	SSC	—	—	NA
Great egret	*Casmerodius albus*	—	SSC	—	—	NA
White-faced ibis	***Plegadis chihi***	**C2**	**—**	**—**	**—**	**NA**
Long-billed curlew	*Numenius americanus*	3c	—	S	—	NA
Loggerhead shrike	***Lanius ludovicianus***	**C2**	**NL**	**S**	**—**	NA
Northern goshawk	***Accipiter gentilis***	**C2**	**S**	**—**	**S**	**NA**
Swainson's hawk	*Buteo swainsoni*	—	—	S	—	NA

Table 7-5. (continued).

Common name	Scientific name	Regulatory status: Federal status[b,c]	State status[c]	BLM status[c]	USFS[d] status[c]	INPS status[c]
Trumpeter swan	***Cygnus buccinator***	**C2**	**SSC**	**S**	**S**	**NA**
Sharptailed grouse	*Tympanuchus phasianellus*	C2	—	S	S	NA
Boreal owl	*Aegolius funereus*	—	SSC	S	S	NA
Flammulated owl	*Otus flammeolus*	—	SSC	—	S	NA
Mammals						
Gray wolf	*Canis lupus*	LE	—	—	—	NA
Pygmy rabbit	***Brachylagus (Sylvilagus) idahoensis***	**C2**	**SSC**	—	**S**	NA
Townsend's western big-eared bat	***Plecotus townsendii***	**C2**	**SSC**	**S**	**S**	**NA**
Merriam's shrew	*Sorex merriami*	—	S	—	—	NA
Long-eared myotis	***Myotis evotis***	**C2**	—	—	—	**NA**
Small-footed myotis	***Myotis subulatus***	**C2**	—	—	—	NA
Western pipistrelle[f]	*Pipistrellus hesperus*	NL	SSC	—	—	NA
Fringed myotis[f]	*Myotis thysanodes*	—	SSC	—	—	NA
California myotis[f]	*Myotis californicus*	—	SSC	—	—	NA
Reptiles and Amphibians						
Northern sagebrush lizard	***Sceloporus graciosus***	**C2**	—	—	—	NA
Ringneck snake[f]	*Diadophis punctatus*	C2	SSC	S	—	NA
Night snake[e]	*Hypsiglena torquata*	—	—	R	—	NA
Insects						
Idaho pointheaded grasshopper[f]	*Acrolophitus punchellus*	C2	SSC	—	—	NA
Fish						
Shorthead sculpin[f]	*Cottus confusus*	—	SSC	—	—	NA

a. This list was compiled from the U.S. Fish and Wildlife Service (USFWS) (letter dated December 6, 1996), the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (CDC 1994), and Radiological and Environmental Sciences Laboratory (RESL) documentation for the INEEL (Reynolds 1994; Reynolds et al. 1986).
b. The USFWS no long maintains a candidate (C2) species listing but addresses former listed species as "species of concern" (USFWS April 30, 1996). the C2 designation is retained here to maintain consistency with previous assessments.
c. Status codes: S = sensitive; 2 = State Priority 2; 3c = no longer considered for listing; M = State-monitored species; NL = not listed; 1 = State Priority 1; LE = listed endangered; LT = listed threatened; E = endangered; SSC = species of special concern; and C2 = Category 2 (defined in CDC 1994). BLM = Bureau of Land Management; INPS = Idaho Native Plant Society; R = removed from sensitive list (non-agency code added here for clarification).
d. United States Forest Service (USFS) Region 4.
e. Recent updates resulting from Idaho State Sensitive Species meeting [BLM, USFWS, INPS, United States Forest Service (USFS)]—(INPS 1995, 1996).
f. No documented sightings at the INEEL, however, the ranges of these species overlap the INEEL and are included as possibilities to be considered for field surveys.

7.2.4.3.2 Burrowing Owl—A burrowing owl habitat survey was conducted at WAG 1 on August 19, 1996. Habitat out to 200 m from the WAG 1 perimeter was included in the survey. No optimal habitat for burrowing owl reproduction was located within 200 m of the WAG 1 perimeter. During habitat surveys, no signs (droppings, pellets, etc., at potential nest burrows) were observed nor were any burrowing owls observed on the survey areas. Four nesting habitat types were described in the survey protocol. In the 200-m perimeter surrounding WAG 1, none of the habitat was Type 1 (optimal nesting habitat), 55% of the habitat was Type 2 (moderate nesting habitat), 35% of the habitat was Type 3 (low use nesting habitat), and 15% of the habitat was Type 4 (unsuitable nesting habitat). However, the BBSs previously revealed burrowing owls on the TAN (WAG 1) route. At least one recorded sighting at WAG 1 was within or very near 600 m from the perimeter. Burrowing owls did not appear in the survey until 1994 and have not appeared since then. There were three total observations of burrowing owls in 1994. Since, burrowing owls are known to often return to previously used sites, WAG 1 is a likely candidate site for burrowing owl use in the future.

7.2.4.3.3 Loggerhead Shrike—During the BBS conducted around WAG 1 from 1985 through 1996 loggerhead shrikes were observed 10 times. Loggerhead shrikes have both nested and hunted within areas of human occupation and have been observed inside contaminated areas at other WAGs. There is a possibility that loggerhead shrikes will become contaminated at WAG 1.

7.2.4.3.4 Ferruginous Hawk, Peregrine Falcon, Northern Goshawk—Recent studies indicate a range of 11–15 nesting pairs of ferruginous hawks on the INEEL; one of these nests was within 6 km of WAG 1. Several ferruginous nests occupied in 1993 were checked by L. D. Flake in summer of 1996 and occupancy rates remained high. Wakeley (1978) observed hunting activity out to 5–6 km from ferruginous nest sites in Utah. Thus, ferruginous hawks within this distance of WAG 1 may be hunting near the WAG. BBS survey data indicate that ferruginous hawks observed at WAG 1 have demonstrated a tendency to use the area over a period of several years. There is no reason not to expect continued use. However, ferruginous hawks tend to avoid areas frequented by humans. For this reason, it is unlikely that ferruginous hawks will nest or hunt at contaminated sites within the WAG. Sightings for the peregrine falcon and northern goshawk on the INEEL have totaled fewer than seven and most have occurred in the southernmost areas of INEEL.

7.2.4.3.5 Pygmy Rabbit—Based on GIS analysis of vegetal, slope, and geological characteristics, it was determined that this site was outside of the range needed to support pygmy rabbits. The selection criteria for exclusion was developed based on characteristics of known pygmy rabbit sites on the INEEL. No pygmy rabbits were found in thirty randomly chosen locations predicted not to contain pygmy rabbits. This indicates a high predictability for determining non-pygmy rabbit locations. Thus we have a high level of confidence that no pygmy rabbits occur within nor near WAG 1.

7.2.4.3.6 Sagebrush Lizard—Sagebrush lizards are known to inhabit grassland areas, and were observed near the TAN area in similar habitat in 1994. A brief survey for sagebrush lizards was conducted in 1996. The surveyed habitat mainly consisted of mixed grassland communities, with a few scattered sagebrush and rabbitbrush shrubs in certain localities. The north and northeast areas on TAN are the most undisturbed grassland areas around the facility. These areas were searched during 1-hour time-constrained surveys on two days. The west and south areas on TAN are disturbed by construction areas, gravel areas, contamination ponds, and borrow pits. These areas were not included in the survey. Although no lizards were observed during the two survey days, it is likely that sagebrush lizards are present and just were not observed during the brief survey period.

7.2.4.3.7 Long-Eared Myotis and Small-Footed Myotis—Little historical data are available for bat use of the WAG 1 ponds. All bat species of concern are insectivores and several species have been recorded hunting in the vicinity of WAG 1. Three individual bats were found at WAG 1 using acoustical

surveys. One, the big brown bat (Epistesicus fuscus), is not a species of interest. However, the presence of the small-footed myotis implies that use of the WAG 1 ponds can be expected by these species.

7.2.4.3.8 Black Tern, Trumpeter Swan, and White-Faced Ibis—The black tern, trumpeter swan, and white-faced ibis are associated exclusively with water sources and have also been recorded fewer than seven times sitewide. The standing water at WAG 1 industrial ponds is most frequently used by many more common species (Cieminski 1993).

7.2.5 Abiotic Components

TAN is located on the alluvial plain of the Big Lost River, in the northeastern section of the INEEL. The topography of the area is relatively flat and the predominant soils include Terreton—silty clay loam (111) soils; Aecet-Rock outcrop complex (1) and Malm-Matheson loamy sand (64) soils; and Terreton-Rock outcrop complex (115), Whiteknob gravely loam (122), Matheson complex (78), and Malm-Bondfarm-Matheson complex soils (see Figure 7-2).

The Terreton silty clay loam (111) soils are very deep, well-drained soils found on old lakebeds. It formed in lacustrine material derived from mixed sources. The soil is moderately calcareous in the surface layer and strongly calcareous below. It is moderately alkaline throughout. Permeability of this Terreton soil is slow and available water capacity is high. Surface runoff tends to be very slow and the hazard erosion is slight.

The Malm-Bondfarm-Matheson complex (432) consists of moderately deep, well-drained, sandy-loam soils on basalt plains. A calcic horizon is present at approximately 30 cm (12 in.). Permeability of these soils is moderately rapid, and the erosion hazards for these soils are slight to moderate (Olsen et al. 1995).

The Aecet-Rock outcrop complex (1) is found on basalt plains on the sides of ridges and convex side slopes. The complex is about 35% Aecet very stony sandy loam, 25% Rock outcrop, and 20% Bereniceton very stony sandy loam. This soil is moderately deep and well drained soil that formed in wind-laid deposits. Permeability is moderately slow, surface runoff is slow or medium, and the hazard of erosion is slight to high. The available water capacity for the Aecet soil is moderate, whereas the available water capacity for the Bereniceton soil is high.

The Terreton-rock outcrop complex (115/115+) soil is found on the outer edge of old lakebeds on basalt plains. Terreton sandy loam makes up 50% of this complex, and Rock outcrop. The remaining 20% consists of Bondfarm loamy sand, Terreton loamy sand, and Aecet soils. The Terreton soil is very deep and well drained. It formed in lacustrine material. Permeability is slow and available water capacity is very high. The surface runoff for this soil is slow to medium, and the hazard of erosion is moderate to high.

The Whiteknob gravely loam (122) soil is deep, well drained, and typically found on alluvial fans. It is formed in alluvium derived from mixed sources. Included with this soil in mapping are small areas of Lidy sandy loam and a soil that is similar to Whiteknob soil but does not have a layer of lime accumulation. Permeability of this soil is moderate and available water capacity is low. Surface runoff is slow, and the hazard of erosion is slight.

The Malm-Matheson loamy sands (64) soil is found on basalt plains. Malm loamy sand makes up about 75% of the complex, and Matheson loamy sand makes up about 15%. The remaining 10% consists of Bereniceton loamy sand, Bondranch loamy sand, and Rock outcrop. This complex is moderately deep to deep and well drained. The profile is calcareous throughout and has a lime accumulation at a depth of

25.4 to 30 cm (10 to 12 in.). Permeability is moderately rapid, and the available water capacity is low or moderate. The surface water runoff for this soil is slow and the hazard of erosion is slight. The hazard of soil blowing is very high.

The Matheson complex (78) soil is commonly found on basalt plains. This complex is deep and well drained. The soil is calcareous throughout and has a layer of lime accumulation at a depth of 25.4 cm (10 in.). Permeability is moderately rapid and available water capacity is moderate or high. Surface runoff for this soil is low or medium, and the hazard of erosion is slight or moderate. The hazard of soil blowing is very high.

Root uptake of contaminants is a complex process that depends on various soil properties such as pH, cation-exchange capacity (CEC), and organic matter content. In addition, the process is highly variable from one plant species to another. While soil-plant relationships are not specifically considered as part of the WAG 1 ERA, this information is presented to support possible comprehensive analyses.

The climate at the WAG 1 area cannot be differentiated from that of the entire INEEL because meteorological data that are ultimately reported are collected in only two locations at the INEEL. Data reported here are collected at the CFA National Oceanic and Atmospheric Administration (NOAA) meteorological station and are extrapolated to the TAN facility (WAG 1). The average annual temperature is 5.4°C (41.7°F) with a mean annual precipitation of 22 cm (8.74 in.). Annual snowfall ranges from a low of about 30 cm (12 in.) to a high of about 102 cm (40 in.), with and an average of 66 cm (26 in.). Wind patterns at the assessment area are from the west-southwest or southwest approximately 40% of the time, and the average speed is 9.3 mph at 6 m (20 ft). Wind direction the remaining 60% of the time is a combination of directions, predominantly due west or northeast.

In addition to the waste ponds and facility drainages at WAG 1, historical flows from the Big and Little Lost Rivers and Birch Creek drainages have formed an extensive system of playa depressions in the areas surrounding WAG 1. Flows from the Big Lost river rarely reach these playa systems and are controlled by a system of dikes and channels south of the facility. Flows from the historical Birch Creek streambed onto INEEL now occur only during short periods in the spring. Primary flow is diverted upstream for hydro-power production before being re-routed and confined to a ponding area (gravel pit) north of WAG 1. It is assumed that no pathways to ecological receptors exist for this medium. Depth to groundwater at TAN varies from slightly less than 61 m (200 ft) at TSF-05 injection well to more than 107 m (350 ft) at ANP-7 well. The aquifer water flows south and southwest under the site and is ultimately discharged at springs along the Snake River in the Thousand Springs area near Twin Falls, Idaho, approximately 145 km (90 mi) from the INEEL (Sehlke et al. 1994). Additionally, based on the INEEL Long Term Use Plan a moratorium on wells will be instituted for 100 years.

7.2.6 Stressor Identification and Characterization

DOE Guidance (DOE 1993) defines a stressor as "any physical, chemical, or biological entity that can induce adverse response." CERCLA is primarily concerned with the effects of chemical stressors. At WAG 1, chemical stressors include a variety of radionuclides, organics, and metals identified at multiple sites.

7.2.6.1 Preliminary Summary of Sites and Data. Sites and contaminants to be considered in the WAG 1 ERA were initially identified by the WAG 1 screening assessment (SLERA). Sites of concern identified in the SLERA were reviewed and evaluated for inclusion in the WAG 1 ERA. Additional release sites identified were also evaluated. In this section, the characterization of the contaminant concentrations at the sites of concern is discussed. The primary source of data for the WAG 1 ERA is the same as that for the human health risk assessment (Section 6 contains more information on the summarization and

calculation of the final data concentrations). Track 1 and Track 2 documents were also used as sources of data when data were not available from the human health risk assessment. Table 7-6 identifies the sites and contaminants evaluated in this WAG 1 ERA and whether human health data were available.

7.2.6.2 *Human Health Concentration Data.* Whenever possible, data from the human health risk assessment were used. The sites and contaminants for which human health exposure point concentration data were used are identified in Table 7-6. In soils, the 95% upper confidence level (UCL) of the arithmetic mean was used to estimate exposure-point concentrations. Maximum concentrations were used when the 95% UCL exceeded the maximum value or when the 95% UCL could not be calculated because data from only three or less samples were available. The data were broken into average concentrations for 0 to 0.15 m (0 to 0.5 ft), 0 to 1.22 m (0 to 4 ft), and 0 to 3 m (0 to 10 ft). For the WAG 1 ERA, the 0.15-m (0.5-ft) concentrations were used to characterize surficial soil concentrations. The subsurface concentrations, considered to be 0.15 to 3 m (0.5 to 10 ft), are based on the 0-to-3-m (0-to-10-ft) concentrations.

Tables 7-7 through 7-9 compare site concentrations to the EBSL and background values for radionuclides, organics, and inorganics, respectively. The concentrations shown in the tables are the same as those used in the human health BRA analysis when available, otherwise they are maximum-observed concentrations. A total of 17 sites were determined to have the potential for posing risk to WAG 1 ecological components. As part of these 17 sites, TSF-06 has been broken down into eight sites and TSF-09 and TSF-18 have been combined. All but two sites had human health sampling data available.

Surface Water and Sediment-For the surface water sites, LOFT-02 and TSF-07, the average surface water and/or sediment concentrations were calculated from data reported in the Track 1 and Track 2 documents. Inorganics, radionuclides, acetone and toluene were detected in surface water sampled from the LOFT-02 disposal pond. Inorganics, radionuclides, and acetone were detected in surface water at the TSF-07 disposal pond. Tables 7-10 and 7-11 compare the chemical concentrations for LOFT-02 and TSF-07 surface water and EBSLs for drinking water ingestion by wildlife (Sample et al. 1996) at LOFT-02.

Sediment data was available for the LOFT-02 pond, from the Track 2 document. Inorganics, radionuclides, organics were detected in sediment at LOFT-02. Table 7-12 summarizes the sediment analytical results and provides comparisons to background and EBSLs for the LOFT-02 disposal pond. LOFT-07 was also evaluated for contaminates in the soil/sediment as soil in the following sections

7.2.6.3 *New Sites.* A number of new sites were added to the WAG ERA that had not been considered in the SLERA. These sites include LOFT-02, TSF Burn Pit (TSF-03), TSF Drainage Pond (TSF-10), TSF Railroad Turntable (TSF-22), TSF Contaminated Well Water Spill (TSF-37), WRRTF Burn Pits (WRRTF-01), WRRTF Evaporation Pond (WRRTF-03), and WRRTF Fuel Oil Leak (WRRTF-13).

7.2.6.4 *Screening of Sites and Contaminants.* Since the initial screening of contaminants at WAG 1 in the SLERA, additional data from newly identified sites and new data from previously identified sites became available. It is the intent of this section to provide a new screening of the sites and contaminants identified in Table 7-6 against both background concentrations and EBSLs. The background concentrations come from the INEEL Background Guidance Document (Rood et al. 1995). EBSLs were calculated specifically for the INEEL as discussed in the Guidance Manual (VanHorn et al. 1995). EBSLs are defined as concentrations of COPCs in soil (or other media) that are not expected to produce any adverse effects to selected ecological receptors under chronic exposure conditions.

Table 7-6. Sites considered in the ERA.

Operable unit	Site	Contaminated media	Human health risk data
1-03	TSF-03	Subsurface	Yes
—	WRRTF-01	Subsurface	Yes
1-04	LOFT-02	Surface-sediment, subsurface, water	No
—	TSF-29	Surface, subsurface	Yes
1-05	TSF-06	Surface, subsurface	Yes
—	TSF-09	Subsurface	Yes
—	TSF-10	Surface-sediment, subsurface, water	Yes
—	TSF-18	Surface, subsurface	Yes
—	TSF-26	Surface, subsurface	Yes
1-06	TSF-07	Surface-sediment, subsurface, water	Yes
—	TSF-08	Subsurface	Yes
1-08	WRRTF-13	Subsurface	Yes
—	TSF-22	Surface, subsurface	Yes
1-09	TSF-36	Subsurface	Yes
—	TSF-37	Subsurface	Yes
1-09	WRRTF-03	Surface, subsurface	No
1-10	LOFT-12	Subsurface	Yes

The stepwise decision process for inclusion of a site and contaminant combination in a WAG ERA is as follows.

1. If the site concentration of the contaminant does not exceed the 95/95% UTL for background concentrations, then the contaminant will not be considered in the WAG ERA for that site.

2. If the site concentration of the contaminant does not exceed the EBSL concentration, then the contaminant will not be considered in the WAG ERA for that site.

3. Otherwise, the contaminant is included in the WAG ERA for the site.

Soil-Tables 7-7, 7-8, and 7-9 compare the contaminant concentrations detected in soil at sites of concern, background, and EBSLs. This screening eliminated six organic contaminants, six inorganic contaminants, and all of the radionuclides. This resulted in the elimination of the following 11 contaminated soil sites from the assessment:

TSF-06, Area B	TSF-06, Area 9	TSF-29
TSF-06, Area 1	TSF-06, Area 11	TSF-36
TSF-06, Area 3	TSF-09/18	TSF-37
TSF-06, Area 5	TSF-26	

Table 7-7. Results of radionuclide screening.[a]

Minimum EBSL (pCi/g) background (pCi/g)	Am-241 3.55+02 1.10E−02	Cm-242 3.20E+02 NA	Cm-243/244 3.36E+02 NA	Co-60 2.30E+03 NA	Cs-134 3.14E+03 NA	Cs-137 5.58E+03 NA	Eu-154 3.31E+03 NA	Eu-155 3.25E+04 NA	H-3 3.43E+05 NA
LOFT-02	—	—	—	—	—	—	—	—	—
LOFT-12	—	—	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	1.85E-01	—	1.5E+02	—	—	—
TSF-06, Area 1	—	—	—	7.46E-01	—	2.09E+01	—	—	—
TSF-06, Area 3	1.50E-01	—	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	1.53E-01	—	1.34E+01	—	—	—
TSF-06, Area 7	—	—	—	7.3E+01	—	1.61E+00	—	—	—
TSF-06, Area 9	—	—	—	3.97E-01	—	8.09E+02	1.67E+00	1.02E+00	—
TSF-06, Area 11	—	—	—	6.29E-01	—	3.16E+02	—	—	—
TSF-07	2.10E-02	—	—	8.77E+01	1.30E-02	1.35E+02	—	—	1.20E+00
TSF-08	—	—	—	2.60E-02	—	7.83E-01	—	—	—
TSF-09, 18	—	—	—	1.10E+02	3.00E-02	9.21E+02	2.51E+00	—	—
TSF-10	—	—	—	—	—	6.30E+00	—	—	—
TSF-22	—	—	—	1.25E-01	—	3.18E+01	—	—	—
TSF-26	—	—	—	2.40E-01	—	1.32E+01	—	—	—
TSF-29	1.30E-01	2.00E-02	5.00E-02	—	—	1.61E+01	—	—	—
TSF-36	—	—	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—	—	—
WRRTF-01	—	—	—	6.00E-02	—	—	—	—	—
WRRTF-03	—	—	—	—	—	—	—	—	—
WRRTF-13	—	—	—	—	—	—	—	—	—

Table 7-7. (continued).

Minimum EBSL (pCi/g) background (pCi/g)	K-40 NA 2.40E+01	Np-237 3.88+02 NA	Pu-239/240 3.79E+02 1.00E–01	Ra-226 4.08E+02 NA	Sr-90 3.34E+03 4.90E–01	Th-232 4.87E+02 1.60E+00	Th-234 4.16E+04 NA	U-235 4.51E+02 NA	U-238 4.64E+02 1.40E+00
LOFT-02	—	—	—	—	—	—	—	—	—
LOFT-12	—	—	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	1.20E+01	—	—	1.68E+01
TSF-06, Area 2	—	—	—	—	—	—	—	—	—
TSF-06., Area 3	—	—	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—	—	—
TSF-07	2.11E+01	—	—	4.54+00	—	7.60E-01	1.80E+00	—	—
TSF-08	—	—	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—	—	—
TSF-29	—	4.00E-02	—	—	—	—	—	8.00E-02	—
TSF-36	—	—	—	—	—	—	—	—	—
TSF-37	—	—	—	—	3.70E-01	—	—	—	—
WRRTF-01	—	—	1.94+00	—	—	—	—	—	—
WRRTF-03	—	—	—	—	—	—	—	—	—
WRRTF-13	—	—	—	—	—	—	—	—	—

a. All values are in pCi/g.

b. A blank cell indicates the corresponding contaminant was not observed at the site.

Table 7-8. Results of organics screening.[a]

Minimum EBSL (mg/kg)	1,1,1-Trichloro ethane 4.08E+02	1,2,4-Trimethyl benzene 1.87E+00	1,4-Dichloro benzene NA	2-Butanone 1.91E+01	2-Hexanone NA	2-Methylnaphthalene 3.34E-02	Acenaphthalene 2.43E+01	Acetone 2.78E-01
LOFT-02	—	—	—	—	—[b]	—	—	—
LOFT-12	—	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	**1.66E+00**	—	—
TSF-06, Area B	—	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—	—
TSF-07	4.30E-02	7.00E-03	**9.00E-03**	9.90E-02	—	—	—	2.40E-01
TSF-08	—	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—	—
TSF-29	—	—	—	—	—	—	—	—
TSF-36	—	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	**1.40E+00**	**1.03E+01**	—	—
WRRTF-03	—	—	—	—	—	—	—	—
WRRTF-13	—	—	—	—	—	**2.90E+02**	7.30E+00	—

Table 7-8. (continued).

Minimum EBSL (mg/kg)	Aroclor-1254 1.43E-02	Aroclor-1260 1.43E-02	Benzo(a) anthracene 3.10E+00	Benzo(a)pyrene 3.34E-02	Benzo(b) fluoranthene 6.67E-02	Benzo(g,h,i) perylene 3.34E-02	Carbon Disulfide 5.91E-01
LOFT-02	—	—	—	—	—	—	—
LOFT-12	—	**1.9E+00**[c]	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—
TSF-07	**6.70E-01**	**1.70E+00**	2.30E–01	**2.10E–01**[d]	**3.00E–01**[d]	**2.30E–01**[d]	5.00E-03
TSF-08	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—
TSF-29	—	—	—	—	—	—	—
TSF-36	—	—	—	3.30E-02	—	—	—
TSF-37	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	—	—	—
WRRTF-03	—	—	—	—	—	—	—
WRRTF-13	—	—	—	—	—	—	—

Table 7-8. (continued).

Minimum EBSL (mg/kg)	Chloroform 1.33E+00	Chloromethane NA	Chrysene 2.33E-01	Dichlorodifluoro methane NA	Di(2-ethyl-hexyl)phthalate 2.63E+00	Di-n-octylphthalate 4.86E+00	Ethylbenzene 2.83E+01
LOFT-02	—	—	—	—	—	—	—
LOFT-12	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—
TSF-07	1.80E-02	**1.00E–02**	**2.40E–01**	**1.20E-02**	**3.90E+00**	7.10E-01	1.20E-02
TSF-08	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—
TSF-29		—	—	—	—	—	—
TSF-36	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	—	—	—
WRRTF-03	—	—	—	—	—	—	—
WRRTF-13	—	—	—	—	2.80E–02	—	1.80E+00

Table 7-8. (continued).

Minimum EBSL (mg/kg)	Fluoranthene 1.74E+01	Fluorene 1.73E+01	Indeno(1,2,3-cd) pyrene 3.34E-02	Methylene Chloride 4.27E-01	Naphthalene 7.37E+00	n-Propylbenzene 5.50E+00	Phenanthrene 1.39E+02
LOFT-02	—	—	—	—	—	—	—
LOFT-12	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	1.24E+00
TSF-06, Area B	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—
TSF-07	3.40E-01	—	**2.00E-01**	1.10E-02	—	1.40E–02	1.70E–01
TSF-08	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—
TSF-29	—	—	—			—	—
TSF-36	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	—	—	8.70E+00
WRRTF-03	—	—	—	—	—	—	—
WRRTF-13	—	1.20E+01	—	—	**5.60E+01**	—	**3.70E+01**

Table 7-8. (continued).

Minimum EBSL (mg/kg)	Propionitrile NA	Pyrene 2.08E+01	Tetrahydrofuran 1.10E-06	TPH 5.50E+00	Toluene 3.03E+01	Vinyl Acetate NA	Xylene 2.86E-01
LOFT-02	—	—	—	—	—	—	—
LOFT-12	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—
TSF-07	**2.00E–02**	3.50E-01	**2.20E–02**	—	7.00E-02	**3.00E–03**	1.20E-02
TSF-08	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—
TSF-29	—	—	—	—	—	—	—
TSF-36	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	—	—	—
WRRTF-03	—	—	—	—	—	—	—
WRRTF-13	—	2.80E+00	—	**1.98E+04**	2.80E+00	—	2.60E+01

a. All values are in mg/kg.

b. A blank cell indicates the corresponding contaminant was not observed at the site.

c. Maximum detected.

d. Bold font indicates that the corresponding site and contaminant combination is included in the WAG 1 WAG ERA analysis.

Table 7-9. Results of inorganics screening.[a]

Minimum EBSL (mg/kg) background (mg/kg)	Aluminum 4.27E+00 2.40E+04	Antimony 7.67E–01 7.40E+00	Arsenic 9.01E-01 7.40E+00	Barium 1.08E-01 4.40E+02	Beryllium 7.34E-01 3.00E+00	Cadmium 2.63E-03 3.70E+00	Calcium NA 3.90+04	Cr-III 3.25E+00 5.00E+01
LOFT-02	2.39E+04[b]	—[c]	—[c]	—	2.40E+00	—	—	2.30E+01
LOFT-12	—	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—	—
TSF-07	**3.40E+04**	**2.74E+01**	**4.92E+01**	**9.74E+03**	2.20E+00	**1.49E+01**	**1.99E+05**	**1.50E+02**
TSF-08	—	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—	—
TSF-29	—	—	—	—	—	—	—	—
TSF-36	—	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	—	—	—	**2.64E+02**
WRRTF-03	—	—	—	3.13E+02	—	**1.17E+01**	—	**7.89E+01**
WRRTF-13	—	—	—	—	—	—	—	—

Table 7-9. (continued).

Minimum EBSL (mg/kg) background (mg/kg)	Cr-VI 1.67E−01 5.00E+01	Cobalt 4.67E-01 1.80E+01	Copper 2.17E+00 3.20E−01	Cyanide 2.15E-02 NA	Fluoride 3.11E+00 NA	Iron NA 3.50E+04	Lead 7.17E−02 2.30E+01	Magnesium 2.56E+00 1.90E+04
LOFT-02	2.30E+01	—	**3.30E+01**	—	**9.90E+01**	—	—	1.73E+04
LOFT-12	—	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	**1.13E+03**	—
TSF-06, Area B	—	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—	—
TSF-07	3.16E+01	**1.99E+01**	**1.09E+03**	**2.93E+00**	—	**4.03E+04**	**3.38E+02**	1.78E+04
TSF-08	—	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—	—
TSF-29	—	—	—	—	—	—	—	—
TSF-36	—	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—	—
WRRTF-01	**2.64E+02**	—	—	—	—	—	**2.35E+03**	—
WRRTF-03	**7.89E+01**	—	—	—	—	—	—	—
WRRTF-13	—	—	—	—	—	—	—	—

Table 7-9. (continued)

Minimum EBSL (mg/kg) background (mg/kg)	Manganese 1.44E+01 7.00E+02	Mercury 6.13E–03 7.40E–02	Nickel 2.77E+00 5.50E+01	Nitrate 3.20E+01 NA	Potassium 2.60E+00 6.30E+03	Selenium 8.34E-02 3.40E-01	Silver 1.39E+00 NA	Sodium 1.10E+02 5.20E+02
LOFT-02	**1.08E+03**	—	—	1.90E+00	—	—	—	—
LOFT-12	—	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—	—
TSF-07	6.95E+02	**4.04E+03**	**7.82E+01**	—	**8.47E+03**	**4.22E+01**	**1.66E+02**	**1.10E+03**
TSF-08	—	**5.90E+01**	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—	—
TSF-10	6.81E+02	—	—	—	—	—	—	—
TSF-22	—	—	—	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—	—
TSF-29	—	—	—	—	—	—	—	—
TSF-36	—	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	—	—	—	—
WRRTF-03	—	—	—	—	—	—	**1.8E+01**	—
WRRTF-13	—	—	—	—	—	—	—	—

Table 7-9. (continued).

Minimum EBSL (mg/kg) background (mg/kg)	Strontium 1.06E+02 NA	Sulfate 1.77E+01 NA	Sulfide NA NA	Thallium 1.17E−01 6.80E−01	Tin 3.84E+00 NA	Vanadium 2.55E−01 7.00E+01	Zinc 6.37E+00 2.20E+02
LOFT-02	—	**1.90E+01**	—	—	—	5.6E+01	—
LOFT-12	—	—	—	—	—	—	—
TSF-03	—	—	—	—	—	—	—
TSF-06, Area B	—	—	—	—	—	—	—
TSF-06, Area 1	—	—	—	—	—	—	—
TSF-06, Area 3	—	—	—	—	—	—	—
TSF-06, Area 5	—	—	—	—	—	—	—
TSF-06, Area 7	—	—	—	—	—	—	—
TSF-06, Area 9	—	—	—	—	—	—	—
TSF-06, Area 11	—	—	—	—	—	—	—
TSF-07	**5.97E+02**	—	**4.27E+03**	**4.82E+01**	**1.15E+03**	**9.45E+01**	**2.40E+03**
TSF-08	—	—	—	—	—	—	—
TSF-09, 18	—	—	—	—	—	—	—
TSF-10	—	—	—	—	—	—	—
TSF-22	—	4.40E+00	—	—	—	—	—
TSF-26	—	—	—	—	—	—	—
TSF-29	—	—	—	—	—	—	—
TSF-36	—	—	—	—	—	—	—
TSF-37	—	—	—	—	—	—	—
WRRTF-01	—	—	—	—	—	—	—
WRRTF-03	—	—	—	—	—	—	—
WRRTF-13	—	—	—	—	—	—	—

a. All values are in mg/kg.

b. Bold font indicates that the corresponding site and contaminant combination is included in the WAG 1 WAG ERA analysis.

c. A — cell indicates that the corresponding contaminant was not observed at the site.

Table 7-10. Surface water analytical results for LOFT-02 Disposal Pond.

	Pond inlet		Reduced flow area		AVG	AWQC[a]	$EBSL_{sw}$[b]	AVG > $EBSL_{sw}$
(ug/L)								
Aluminum	344	372	12	616	336	N/A	4,470	No
Barium	9.7	11	11	15	11.7	N/A	23,100	No
Beryllium	1.8	1.9	1.5	1.7	1.7	5.3	2,830	No
Chromium	2.5	2.4	2.6	3.1	2.7	210[c]	4,300	No
Manganese	6.1	7.8	5.7	13	8.2	N/A	377,000	No
Mercury	0.04	0.02	0.03	0.03	0.03	0.012	46	No
Vanadium	13	12	12	12	12.3	N/A	835	No
Zinc	97	67	37	24	56.3	110[c]	62,300	No
(pCi/L)								
Americium-241	0.06	0.002	0.04	0.22	0.08	N/A	N/A	—
Cesium-137	N/A	N/A	4.4	N/A	4.4	N/A	N/A	—
Gross alpha	3	14	7	19	10.8	N/A	N/A	—
Gross beta	21	39	17	15	23	N/A	N/A	—
Tritium	100	N/A	N/A	N/A	100	N/A	N/A	—
Total strontium	2	160	N/A	N/A	81	N/A	N/A	—
Total uranium	0.93	1.1	0.84	1.7	1.14	N/A	N/A	—
(ug/L)								
Acetone	11	10	14	10	11.3	N/A	42,800	No
Toluene	1	1	N/A	N/A	1	17,500[d]	60,300	No

Surface water analytical results reported from *TAN Track 2 Investigation for OU 1-04* (DOE 1996)
N/A: Not available.
$EBSL_{sw}$: Ecological-based screening level for surface water, from *Toxicological Benchmarks for Wildlife: 1996 Revision* (Sample et al. 1996)
a. EPA Ambient Water Quality Criteria, chronic value (EPA 1987).
b. Most conservative NOAEL-based benchmark for ingestion of water (Sample et al. 1996).
c. Hardness-dependent; assumed 100 mg/L $CaCO_3$.
d. Acute value; used in the absence of a chronic value.

Table 7-11. Surface water analytical results for TSF-07 Disposal Pond.

	Minimum	Maximum	AVG	AWQC[a]	$EBSL_{sw}$[b]	AVG > EBSLsw
(ug/L)						
Barium	72	241	156.5	N/A	23,100	No
Beryllium	2.5	4.4	3.5	5.3	2,830	No
Cadmium	1	1.1	1.1	1.1[c]	4,132	No
Chromium	2	19	10.5	210[c]	4,300	No
Copper	12	102	57	1,000	65,200	No
Mercury	0.02	0.42	0.22	0.012	46	No
Nickel	6	29	17.5	160[c]	171,360	No
Silver	6	35	20.5	0.12	NA	No
Vanadium	17	48	32.5	N/A	835	No
Zinc	57	389	223	110[c]	62,300	No
(pCi/L)						
Americium-241	0.07	0.13	0.10	N/A	N/A	—
Cobalt-60	5.9	31	18.5	N/A	N/A	—
Cesium-137	7.2	93	50.1	N/A	N/A	—
Tritium	0	100	50	N/A	N/A	—
Total strontium	3.5	12	7.8	N/A	N/A	—
Gross alpha	8	22	15	N/A	N/A	—
Gross beta	30	85	57.5	N/A	N/A	—
(ug/L)						
Acetone	0.01	11	5.5	—	42,800	No

Surface water analytical results reported from Track 1 Sites:

Guidance for Assessing Low Probability Hazard Sites at the INEL for TSF-07 Disposal Pond OU 1-06 (DOE 199?).

NA: Not available.

$EBSL_{sw}$: Ecological-based screening level for surface water, from *Toxicological Benchmarks for Wildlife: 1996 Revision,* (Sample et al. 1996).

a. EPA Ambient Water Quality Criteria, chronic value (EPA 1987).
b. Most conservative NOAEL-based benchmark for ingestion of water (Sample et al. 1996).
c. Hardness-dependent; assumed 100 mg/L $CaCO_3$.

Table 7-12. Sediment analytical results for LOFT-02 Disposal Pond.

	Pond inlet		Reduced flow area		AVG	Background	MAX > Backgd	$EBSL_{sed}$	AVG > $EBSL_{sed}$
(mg/kg)									
Aluminum	19,200	16,900	14,300	23,900	18,575	24,000	No	N/A	—
Barium	218	188	181	265	213	440	No	N/A	—
Beryllium	2.2	2.1	1.8	2.4	2.125	3	No	N/A	—
Cadmium	0.88	0.84	0.52	1	0.81	3.7	No	1.2[a]	—
Chromium	27	29	20	27	25.75	50	No	81[a]	—
Cobalt	9.7	8	7.9	12	9.4	18	No	N/A	—
Copper	30	26	22	33	27.75	32	Yes	34[a]	No
Lead	13	9.9	11	17	12.725	23	Yes	46.7	—
Manganese	851	393	527	1,080	712.75	700	Yes	460[c]	Yes
Mercury	0.04	0.03	0.04	0.03	0.035	0.074	No	0.15[a]	—
Nickel	41	35	31	49	39	55	No	20.9[a]	—
Silver	1.5	1.3	N/A	N/A	1.4	ND	Yes	1.0[a]	Yes
Vanadium	45	41	42	56	46	70	No	N/A	—
Zinc	126	113	88	143	117.5	220	No	150[a]	—
(pCi/kg)									
Americium-241	6.6	6.3	3.7	2.9	4.875	19	No	N/A	—
Gross alpha	8,400	3,900	4,400	N/A	5,567	17,460[d]	No	N/A	—
Gross beta	6,100	6,500	6,000	N/A	6,200	28,350[d]	No	N/A	—
Tritium	1,000	800	200	300	575	N/A	N/A	N/A	N/A

Table 7-12. (continued).

	Pond inlet		Reduced flow area		AVG	Background	MAX > Backgd	$EBSL_{sed}$	AVG > $EBSL_{sed}$
Potassium-40	14,000	13,000	12,000	15,000	13,500	32,000	No	N/A	—
Total strontium	N/A	10	N/A	180	95	N/A	N/A	N/A	N/A
Total uranium	1,600	1,300	1,200	1,400	1,375	2,340[d]	No	N/A	—
(ug/kg)									
Acetone	99	89	74	85	86.75	N/A	N/A	9.12[b]	No
Methylene chloride	N/A	N/A	12	15	13.5	N/A	N/A	7,272[b]	No
2-Butanone	160	230	120	110	155	N/A	N/A	24,066[b]	No
1,1,1-Trichloroethane	26	18	12	18	18.5	N/A	N/A	4,882[b]	No
Toluene	5	15	13	3	9	N/A	N/A	128,218[b]	No

Sediment analytical results and background concentrations reported from *TAN Track 2 Investigation for OU1-04* (DOE, 1996).

N/A: Not available.

$EBSL_{sed}$: Ecological-based screening level for sediment, from *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota* (Jones et al. 1996).

a. Effects Range Low (ERL) (Long et al. 1995).

b. Equilibrium partitioning-derived sediment quality benchmark; lowest chronic value for daphnids; assumes 1% TOC (Jones et al. 1996).

c. Ontario Ministry of the Environment low effect level (Persaud et al. 1990).

d. Background value from Track 2 document, used in the absence of background values from Rood et al. (1995).

Surface Water and Sediment—Tables 7-10 and 7-11 compare the contaminant concentrations detected in the LOFT-02 and TSF-07 ponds' water to AWQC (EPA 1987) and EBSLs for drinking water ingestion by wildlife (Sample et al. 1996). Concentrations in the surface water of the waste ponds in excess of AWQC are not of concern because the ponds do not provide aquatic habitat (e.g., fish). However, wildlife exposure through the drinking water pathway is of potential concern. Chemical concentrations in surface water did not exceed the EBSLs for wildlife ingestion of drinking water. No EBSL for wildlife ingestion of water was available for silver and therefore the potential risk from silver to ecological receptors could not be evaluated for TSF-07. For radionuclides the concentration in the water was determined to be below levels that would be harmful.

Sediment data was available for the LOFT-02 pond only. The sediment data from the Track 2 document was tabulated and the maximum sediment concentration was compared to INEEL background for inorganics (Table 7-12). Inorganics which exceeded background concentrations included copper, lead, manganese, and silver. For these inorganics, and for all detected organics, the average sediment concentration was compared to sediment EBSLs for aquatic invertebrates (Jones et al. 1996). Table 7-12 summarizes the sediment analytical results and provides comparisons to EBSLs for LOFT-02 Disposal Pond. All organics were detected at concentrations below the EBSLs. Manganese concentrations in sediment at LOFT-02 exceeded the EBSL for sediment-associated invertebrates. However, the background concentration of manganese also exceeded the EBSL (±12%) three of four manganese samples were within the same order of magnitude as the background concentration and the average concentration was just slightly (1–2%) higher than background. Therefore, manganese in sediment of the LOFT-02 pond is not expected to pose a risk to ecological receptors. The average silver concentration in sediment was only slightly greater than the very conservative EBSL.

7.2.6.5 Summary of Sites Retained for Further Assessment. The EBSL screening process resulted in the following nine sites being retained for further assessment in the WAG 1 ERA: TSF-03, WRRTF-01, LOFT-02, TSF-07, TSF-08, WRRTF-13, TSF-22, WRRTF-03, and LOFT-12.

7.2.7 Pathways of Contaminant Migration and Exposure

Sites of concern were determined to have the potential for posing risk to WAG 1 ecological components through three primary media: contaminated surface soil, contaminated subsurface soil, and contaminated surface water, as discussed in the following sections. Surface water samples were analyzed only for the LOFT-02 and TSF assessment areas. Contaminated perched water and groundwater sites are also present, but for this assessment, it is assumed that no pathways to ecological receptors exist for these sites. Groundwater is generally considered inaccessible to ecological receptors because of the depth to the aquifer at the INEEL [60 to 180 m (200 to 600 ft)] and the large distance to surface springs [more than 160 km (100 mi)] (EG&G Idaho 1993). Perched water at TAN is limited and at depths greater than 3 m (10 ft). Major contaminant classes for all media include metals, organic compounds, and radionuclides.

7.2.7.1 Surface Soil. Contaminated surface soil represents the major source of possible contaminant exposure for WAG 1 ecological components. Surface soil, as defined for use in INEEL WAG ERAs, includes the uppermost 0.15 m (0.5 ft). Five of the nine WAG 1 sites of concern represent sources of surface soil contamination resulting from past contamination.

The model for ecological pathways and exposure for WAG 1 contaminated surface soil is shown in Figure 7-3. This model depicts the various mechanisms for surface soil contamination transport as follows:

- Wind and water erosion
- Leaching and infiltration

- Plant uptake
- Burrowing animal translocation.

Transportation of contaminated soils through these mechanisms may result in contamination of various other media or secondary sources, including the following onsite and offsite sources:

- Surface water
- Surface soil
- Subsurface soil
- Vegetation.

Receptors having potential for direct exposure to WAG 1 surface soils are presented on Table 7-13. Ecological receptors can be exposed to contaminated media directly through ingestion of vegetation, water, or through physical contact or inhalation. Inhalation and physical contact, however, are considered to play minor roles in the exposure to surface contamination for WAG 1. The functional groups identified as having direct exposure include most terrestrial bird, mammal, reptile, and insect species potentially present in the WAG 1 area.

7.2.7.2 Subsurface Soil. The model for ecological pathways and exposure for WAG 1 contaminated subsurface soils is presented in Figure 7-4. Several of the WAG 1 sites of concern are contaminated subsurface soil sites resulting from buried contaminated soil or sediments, leaking USTs, and past surface spills followed by leaching. For the analysis, subsurface soils are defined at depths of 15 cm to 3 m (0.5 to 10 ft). Contaminants in subsurface soil can be transported to ecological receptors by plant uptake and translocation by burrowing animals. Contamination depths greater than 3 m (10 ft) bgs are considered inaccessible to ecological receptors, because this is generally below the root zone of plants and burrowing depth of ground-dwelling animals.

Insects and burrowing animals have the potential for bringing subsurface soils from buried waste to the surface. Once contaminated soil is brought close to the surface, transport and exposure scenarios for ecological receptors are the same as for surface soil. Subsurface contamination, inhalation and direct contact (by burrowing animals) are more important exposure routes than for surface contamination. Receptors having a potential for direct exposure to WAG 1 subsurface soil contamination are presented in Table 7-13. These receptors include animals dwelling below ground and deep rooting plants. Because subsurface soil contamination may be translocated to the surface by burrowing and plant uptake, other terrestrial species also have some potential for exposure through this pathway. No site-specific or other data were researched to confirm or evaluate this source of surface contamination, which is considered a data gap. A thorough literature analysis of this potential contamination exposure route should be evaluated in the INEEL-wide ERA.

7.2.7.3 Surface Water. Three sources of standing water were included in the WAG 1 assessment: LOFT-02, TSF-07, and TSF-10. LOFT-02 is the LOFT Disposal Pond, contaminants include metals in sediment and water. Use of the 3-acre LOFT-02 Disposal Pond by a variety of wildlife species and the presence of aquatic invertebrates have been documented (refer to Section 7.2.4.2). TSF-07 is an unlined disposal pond. The active portion of the pond is 1.5 acres in size. The 1-acre overflow pond has rarely been used. The TSF Disposal Pond supports aquatic invertebrates and is also known to be frequented by a variety of wildlife species (refer to Section 7.2.4.2). TSF-10 is the TSF Drainage Pond. This pond was originally designed as an infiltration pond. Presently no operations or processes discharge to the TSF

Table 7-13. Summary of WAG 1 direct exposure pathways and receptors.

Exposure medium	Exposure route	Potential receptors (functional groups)[a]
Subsurface soil (Direct)	Ingestion (dietary)	AV322A, M122A, M322, M422, R222, R322, terrestrial invertebrates, microorganisms, individual plant species (uptake)
	Physical contact	AV222A, M122A, M322, M422, R222, R322
	Inhalation	Not addressed
Surface soil (Direct)	Ingestion (dietary)	AV122, AV212, AV222, AV322, AV322A, AV422, M122, M122A, M322, M422, M422A, R222, R322, terrestrial invertebrates, microorganisms, individual plant species (uptake)
	Physical Contact	AV122, AV212, AV222, AV322, AV322A, AV422, M122, M122A, M322, M422, M422A, R222, R322, terrestrial invertebrates, microorganisms
	Inhalation	Not addressed
Vegetation (Direct)	Ingestion	AV122, AV143, AV422, M122, M122A, M422, phytophagous insects
	Physical contact	AV122, AV222, AV310, AV322, M122, M122A, terrestrial invertebrates
Surface water (Direct)	Ingestion (dietary)	AV122, AV143, AV212, AV222, AV310, AV322, AV422, M122, M122A, M210A, M322, M422, M422A, R222, R322, aquatic microfauna
	Physical contact	AV143, aquatic microflora/fauna
Sediments (Direct)	Ingestion (dietary)	AV143, benthic invertebrates
	Physical contact	AV143, benthic invertebrates
	Inhalation	Not addressed
Prey (Indirect)	Ingestion	AV212, AV222, AV310, AV322, AV422, M210A, M210, M322, M422, M422A, R222, R322, entomophgous, zoophagous, and saprophagous insects

a. Individual species associated with these groups are listed in Appendix F.

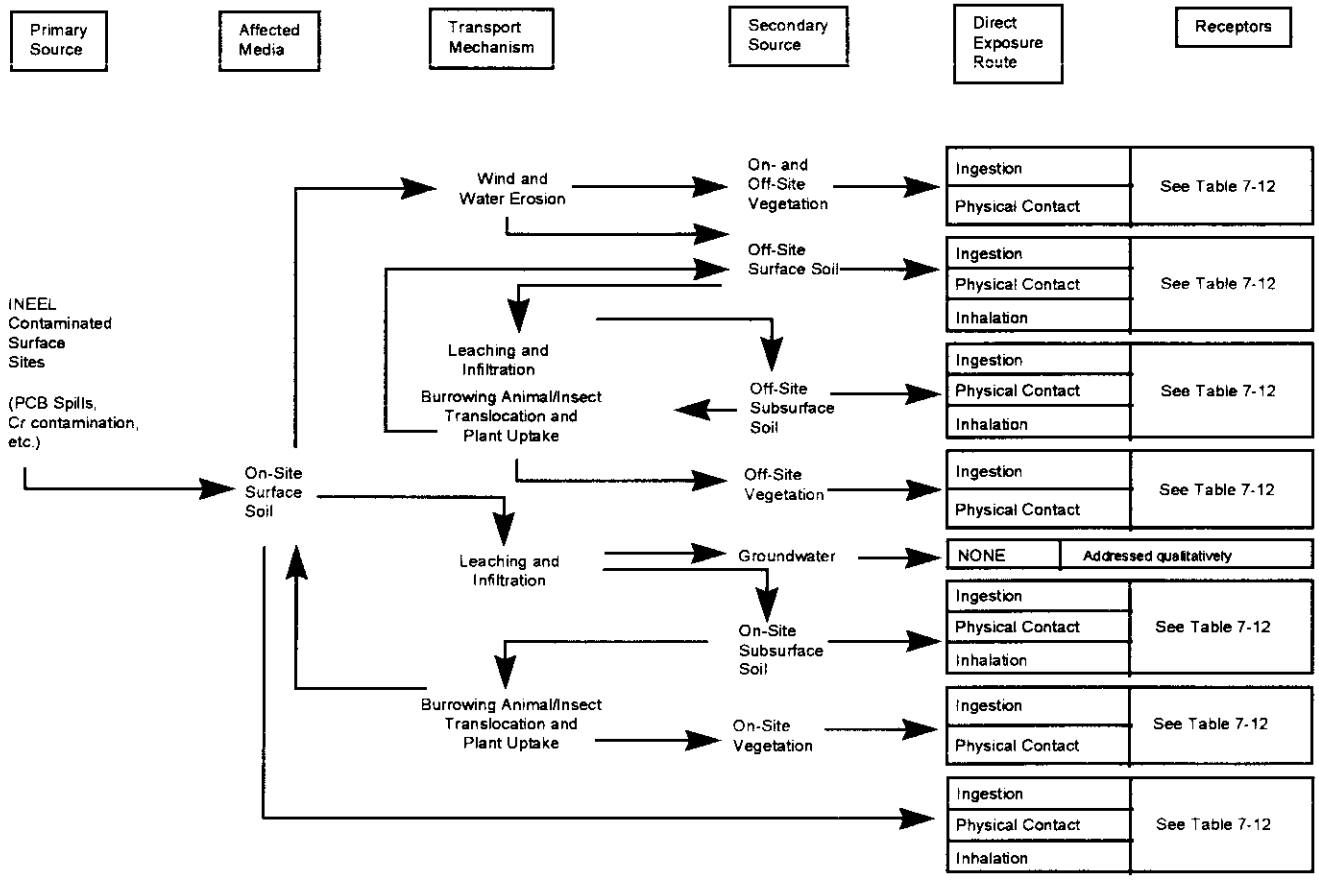

Figure 7-3. Model for ecological pathways and exposure for WAG 1 surface contamination.

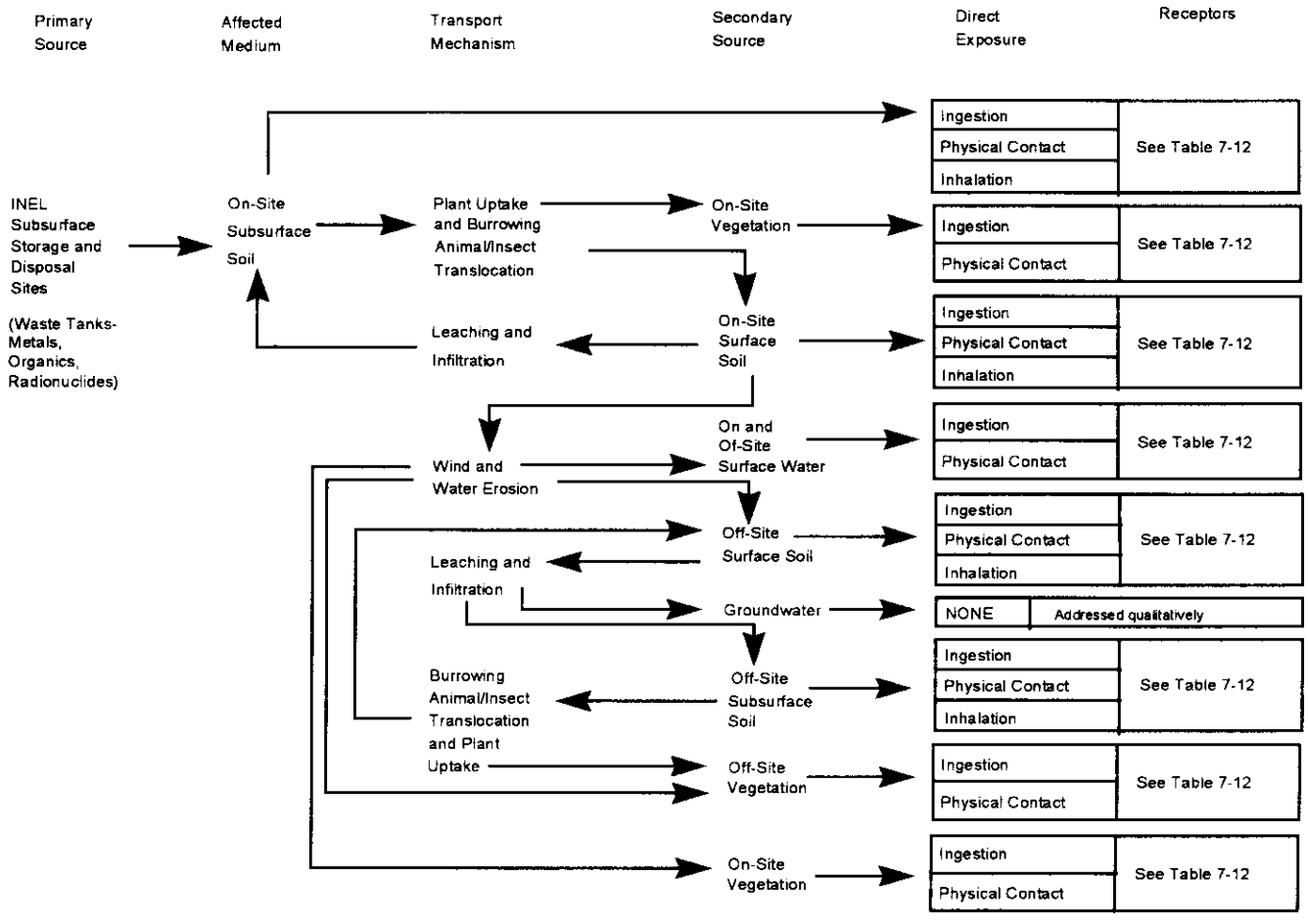

Figure 7-4. Model for ecological pathways and exposure for WAG 1 subsurface storage and disposal sites.

Drainage Pond and it is usually dry. The TSF Drainage Pond does receive intermittent surface runoff and occasional discharge of monitoring well purge water. Because the pond is usually dry and surface water is almost never present, the TSF Drainage Pond is evaluated for ecological receptors' exposure to contaminants in soil only.

Tables 7-10 and 7-11 compare the chemical concentrations detected in LOFT-02 and TSF-07 surface water to EBSLs for drinking water ingestion by wildlife.

The model for pathways and exposure for contaminated surface water sites at the INEEL is shown on Figure 7-5. Ecological receptors having a potential for direct exposure to surface water pathways are identified on Table 7-13.

7.2.8 Conceptual Site Model

The models for pathways and exposure for surface soil, subsurface soil, and surface water were integrated to produce the WAG 1 CSM shown in Figure 7-6. This model reflects both direct (previous sections) and indirect (i.e., predation) receptor exposure pathways for WAG 1 COPCs.

7.2.9 Development of Assessment Endpoints

This section addresses the development of assessment endpoints. Assessment endpoints are "formal expressions of the actual environmental values that are to be protected" (Suter 1989). Assessment endpoints developed for the WAG 1 ERA are presented on Table 7-14. The endpoints were developed around the protection of INEEL biota represented by functional groups and individual T/E and C2 species known to exist at WAG 1 and identified as having potential for exposure to COPCs. Each T/E species is addressed individually in the risk analysis, whereas potential effects to other receptors of concern are dealt with at the functional group level. Assessment endpoints defined for the WAG 1 ERA reflect the INEEL-wide hazard control and policy goals discussed in the Guidance Manual (VanHorn et al. 1995) and incorporate the suggested criteria for developing assessment endpoints including ecological relevance and policy goals (EPA 1992; Suter 1993).

These assessment endpoints are the focus of WAG ERA risk characterization and link the measurement endpoints to the WAG ERA goals. The primary objective of this WAG ERA is to identify COPCs and the levels of those contaminants that represent potential risk to WAG 1 ecological components. Consequently, toxic effects to ecological components as a result of exposure to COPCs were considered a primary concern for WAG 1 biota. Although adverse effects caused by physical stressors are also of concern in evaluating potential risks to INEEL ecological components, these effects are not addressed by the WAG ERA assessment. A hazard quotient (HQ) approach was used to establish the potential for contaminants to contribute to ecological risk to WAG 1 individuals and populations. The HQ is used to indicate whether a potential exists for adverse effects. The use of the HQ as an indicator of effects is discussed in detail in Section 7.4.1.

7.2.10 Measurement Endpoint Selection

This section describes the selection of measurement endpoints for the WAG 1 ERA. Measurement endpoints are measurable responses to ecological receptors to contaminants that can be related to WAG ERA assessment endpoints. For the WAG 1 ERA, the ecological components (flora and fauna) were not measured or surveyed directly. Rather, published references were used as the primary sources of ecological

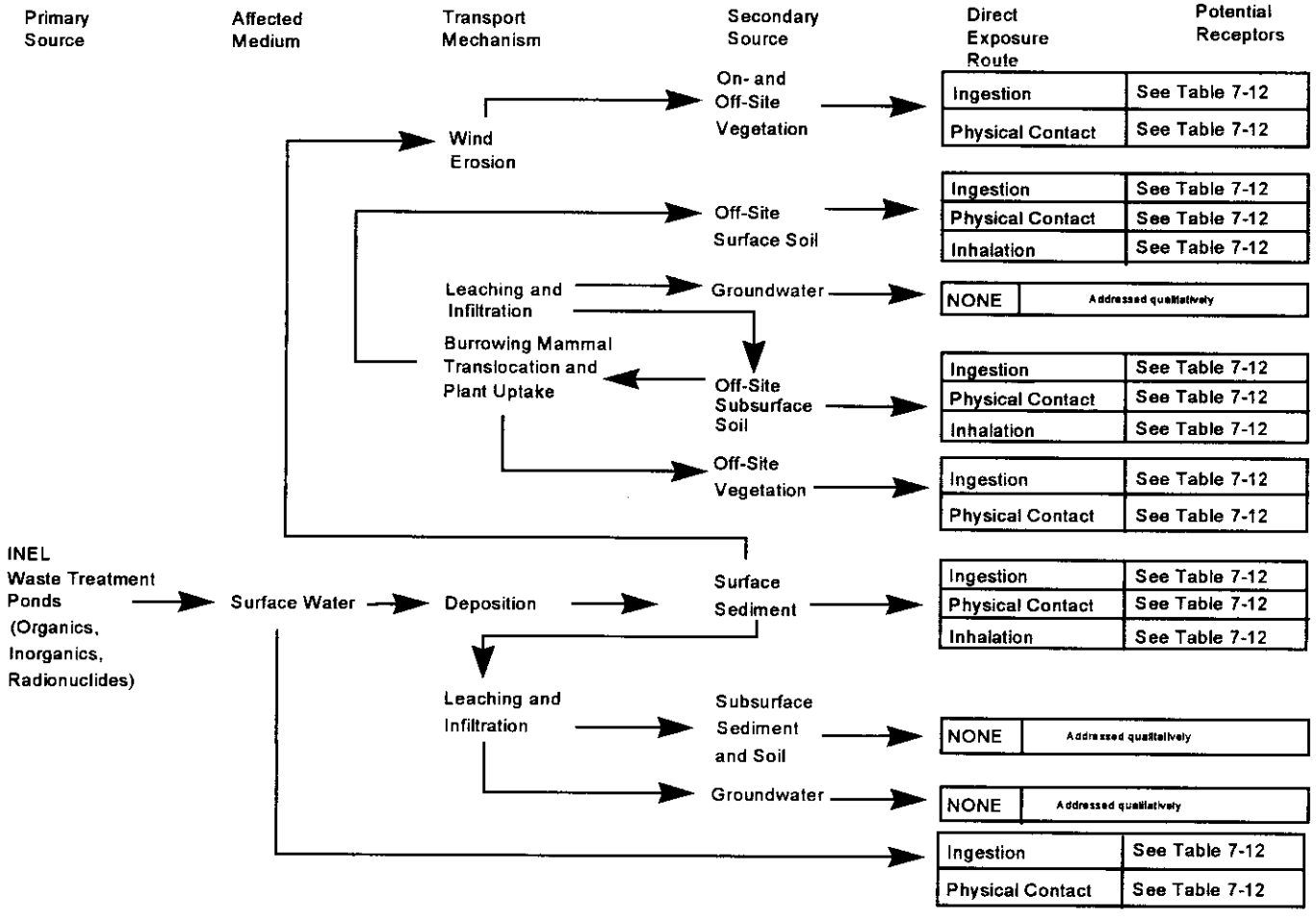

Figure 7-5. Model for ecological pathways and exposure for WAG 1 surface water contamination.

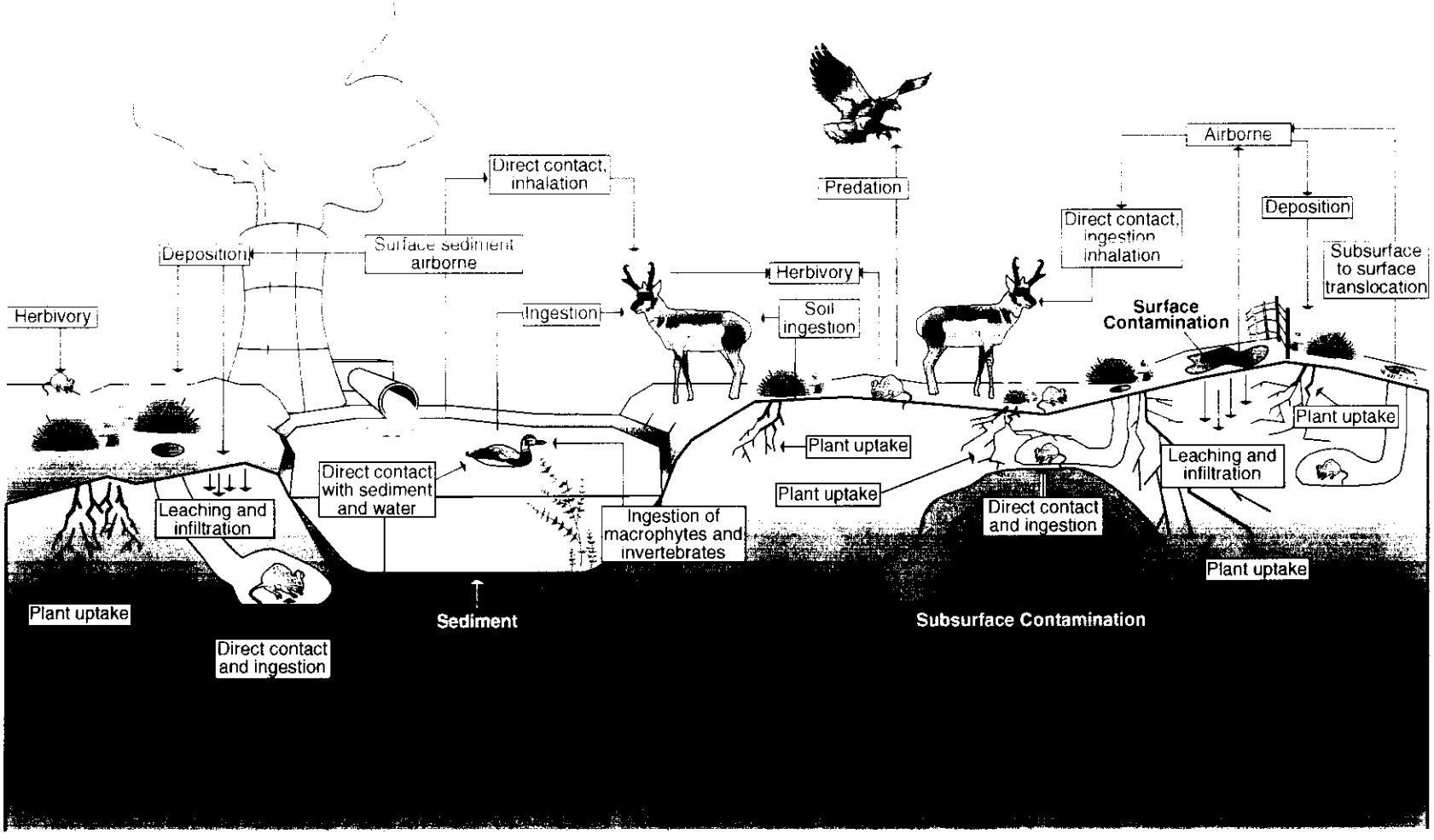

Figure 7-6. WAG 1 ecological conceptual site model.

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Table 7-14. Summary of assessment endpoints for WAG 1 ERA.

Management Goals	WAG ERA Endpoint	Indicator of Risk[a]
Maintain INEEL T/E individuals and populations by limiting exposure to organic, inorganic, and radionuclide contamination.	No indication of possible effects to T/E individuals and populations as a result of contaminant exposure: peregrine falcon, northern goshawk, bald eagle, burrowing owl, ferruginous hawk, loggerhead shrike, white-faced ibis, black tern, pygmy rabbit, Townsend's western big-eared bat, long-eared myotis, small-footed myotis, sagebrush lizard, and trumpeter swan individuals and populations (Functional Groups AV310, AV322, AV322A, AV233, AV210, R222, M123 and M210A).	HQ[b] ≥ target value
Maintain INEEL T/E individuals and populations by limiting exposure to physical stressors.	Not addressed by WAG ERA	N/A
Maintain abundance and diversity of INEEL native biota by limiting exposure to organic, inorganic, and radionuclide contamination.	No indication of possible effects to WAG native vegetation communities as a result of contaminant exposure.	HQ ≥ target value
	No indication of possible effects to WAG wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual model: waterfowl, small mammals, large mammals, song birds, raptors, top predators, invertebrates).	HQ ≥ target value
Maintain abundance and diversity of INEEL native biota by limiting exposure to physical stressors physical stressors.	Not addressed by WAG ERA	N/A

Source: Suter 1993

a. Based on original guidance provided by EPA (1994), this column might have been called the "measurement endpoint." Subsequent guidance from EPA (1996) now discusses measures/indicators of effects.

b. HQ—hazard quotient. The target value is 1 for nonradionuclide contaminants and 0.1 for radionuclide contaminants. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and therefore does not represent a statistical probability of occurrence of adverse ecological effects. HQs provide essentially a "yes or no" determination of risk and are therefore well-suited for screening-level assessments (EPA 1988b). A limitation of the quotient method is that is does not predict the degree of risk or magnitude of effects associated with specified levels of contamination (EPA 1988b).

and toxicological data from which measurement endpoints were derived. Values extracted from these references were used to calculate EBSLs for all ecological receptors and to develop TRVs for the contaminants.

Table 7-15 summarizes the measurement endpoints developed to address WAG 1 screening-level assessment endpoints. Quantified critical exposure (QCE) levels and adjustment factors (AFs) were constructed from the literature to develop appropriate TRVs for receptors associated with WAG 1 contaminant pathways. Criteria for development of these TRVs are discussed in Section 7.3.4.1. In general, the criteria incorporate the requirements for appropriate measurement endpoints, including relevance to an assessment endpoint, applicability to the route of exposure, use of existing data, and consideration of scale (VanHorn et al. 1995).

Published values for species dietary habits, home ranges, site use, exposure duration, soil ingestion, food digestion, and body weights for the representative species are listed on Table 7-16 and the average contaminant concentration in each medium were used to calculate dose for each affected receptor. The measurement endpoints are the modeled dose as compared to the TRVs for each contaminant for each receptor or functional group. The modeled dose was divided by the TRV to produce an HQ for each contaminant and receptor of concern. The HQ is ultimately used to measure whether the assessment endpoint has been attained, that is, survival and reproductive success are ensured for the receptor groups being assessed (HQs are less than target value for all receptors for each contaminant).

7.3 Analysis

The risk analysis step of the WAG 1 ERA involves assessing exposure to contaminants (characterization of exposure) and potential effects of exposure (characterization of effects). These activities are conducted interactively to ensure that the methods used to assess exposure and effects are compatible. Assessing exposure and effects is based on the ecological endpoints and conceptual models derived during the problem formulation presentation.

A primary step in analyzing risk is to determine the potential for site-related contaminants to increase the incidence of adverse effects in exposed populations. The objective of this activity is to estimate the magnitude, frequency, duration, and route of exposure to site-related contaminants by ecological receptors. Accomplishing this task involves completing the following steps:

1. Discuss the factors which influence contaminant fate and transport.

2. Estimate dose for all functional groups and contaminants.

7.3.1 Discussion of Contaminant Fate and Transport Properties

This section discusses the behavior and fate of the contaminants in the terrestrial environment. No formal fate and transport modeling was conducted for the WAG 1 ERA. Environmental fate properties are important because they provide information on the environmental behavior of contaminant compounds throughout various environmental media. Contaminants for WAG 1 surface and subsurface soils, which are identified by the WAG 1 ERA, include the following:

Table 7-15. Summary of WAG 1 ERA endpoints.

WAG 1 assessment endpoint	Ecological component	Functional group (other groups represented)	Measurement species (TRV test species)
No indication of possible effects to T/E individuals and populations as a result of contaminant exposure:	Pygmy rabbit	M122A (M123)	Rat, mouse/meadow vole (M122A), deer mouse
	Peregrine falcon, northern goshawk	AV310	Chicken, goshawk, American kestrel/red-tailed hawk (AV322)
	Ferruginous hawk, loggerhead shrike, bald eagle, burrowing owl	AV322, AV322A	Chicken, goshawk, American kestrel/red-tailed hawk (AV322)
	Townsend's western big-eared bat, long-eared myotis, small-footed myotis	M210A (M210)	None located
	Sagebrush lizard	R222	None located
No indication of possible effects to WAG 1 native vegetation communities as a result of contaminant exposure.	Vegetation	Sagebrush, bunchgrass	Bush beans, crop plants
No indication of possible effects to WAG 1 wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual model: waterfowl, small mammals, large mammals, song birds, raptors, top predators, invertebrates)	Small mammals	M422, M122A (M222, M123)	Rat, mouse/meadow vole (M122A), deer mouse
	Mammalian carnivore/omnivores	M422A, M322	Rat mouse, dog, cat, mink/fox
	Mammalian herbivores	M121 (M122)	Rat, mouse, mule deer/pronghorn
	Avian carnivores	AV322	Goshawk, American kestrel/red-tailed hawk (AV322)
	Avian herbivores	AV122 (AV122)	Chicken, pheasant, quail, passerines/sharp-tailed and ruffed grouse
	Avian insectivore	AV210, AV222 (AV210A, AV221, AV22A)	Chicken, pheasant, quail, passerines/American robin, cliff swallow
	Avian carnivores/omnivores	AV422	Chicken, pheasant, quail passerines
	Mammalian insectivore	M210A (M210)	None located
	Reptiles	R222, R322	None located/Western racer
	Invertebrates	*Phytophagous, saprophagous, entomophagous*	Unidentified

Table 7-16. WAG 1 species parameters.

Functional groups	PP[a]	PV[b]	PS[c]	ED[d]	IR (kg/day)[e]	BW (kg)[f]	HR (Ha)[g]	WI (L/day)[h]
Avian herbivores (AV122)	0.00E+00	9.07E–01	9.30E–02	1.00E+00	1.46E–03	3.50E–03	5.18E+00	1.33E–03
Avian herbivores- aquatic (AV143)	0.00E+00	9.18E–01	8.20E–02	6.50E–01	2.92E–02	3.47E–01	Aquatic	2.90E–02
Avian insectivores (AV221)	9.70E–01	0.00E+00	3.00E–02	6.50E–01	1.99E–03	6.65E–03	1.30E-01	2.05E-03
Avian insectivores (AV222)	9.07E–01	0.00E+00	9.30E–02	1.00E+00	3.07E–03	1.09E–02	3.80E–01	2.86E-03
Avian carnivores (AV310)	9.80E–01	0.00E+00	2.00E–02	1.00E+00	1.02E–02	1.47E–01	1.01E+03	1.63E-02
Avian carnivores (AV322)	9.80E–01	0.00E+00	2.00E–02	1.00E+00	7.44E–03	4.25E–02	9.00E+00	7.11E–03
Avian omnivores (AV422)	6.27E–01	2.80E–01	9.30E–02	1.00E+00	1.13E–02	8.02E–02	1.10E+01	1.09E–02
Avian omnivores- aquatic (AV442)	6.20E–01	2.70E-01	1.10E–01	1.00E+00	4.41E–02	6.54E–01	Aquatic	4.44E–02
Mammalian herbivores (M122)	0.00E+00	9.37E–01	6.30E–02	1.00E+00	3.30E–03	1.10E–02	2.30E-01	1.71E–03
Mammalian herbivores (M122A)	0.00E+00	9.23E–01	7.70E–02	1.00E+00	4.27E–03	1.57E–02	3.00E–01	2.35E–03
Mammalian insectivores (M210)	9.80E–01	0.00E+00	2.00E–02	5.00E–01	1.43E–03	9.03E–03	2.39E+00	1.43E–03
Mammalian insectivores (M210A)	9.80E–01	0.00E+00	2.00E–02	2.50E–01	1.43E–03	4.65E–03	2.39E+00	7.88E–04
Mammalian insectivores (M222)	9.76E–01	0.00E+00	2.40E–02	1.00E+00	1.66E–03	6.00E–03	1.24E–01	9.91E–04
Mammalian carnivore (M322)	9.23E–01	0.00E+00	7.70E–02	1.00E+00	1.66E–02	1.78E-01	1.30E+01	2.09E–02
Mammalian omnivores (M422)	8.04E–01	1.00E–01	9.40E–02	1.00E+00	3.06E–03	1.70E–02	7.20E–01	2.53E–03
Mammalian omnivores (M422A)	8.06E–01	1.00E–01	9.40E–02	1.00E+00	2.60E–01	5.05E+00	1.50E+01	4.25E-01
Reptilian insectivores (R222)	9.76E–01	0.00E+00	2.40E–02	1.00E+00	5.60E–05	6.60E–03	1.17E–01	0.00E+00
Reptilian carnivores (R322)	9.52E–01	0.00E+00	4.80E–02	1.00E+00	6.80E–03	1.50E–02	3.00E+00	0.00E+00
Ferruginous hawk (*Buteo regalis*)	9.80E–01	0.00E+00	2.00E–02	1.00E+00	7.44E–03	4.25E-02	9.00E+00	7.11E–03
Burrowing owl (*Athene cunicularia*)	9.70E–01	0.00E+00	3.00E-02	2.50E-01	1.73E–02	1.55E–01	1.00E+01	1.69E–02
Loggerhead shrike (*Lanius ludovicianus*)	9.80E–01	0.00E+00	2.00E–02	1.00E+00	7.44E–03	4.25E–02	9.00E+00	7.11E–03

Table 7-16. (continued).

Functional groups	PP[a]	PV[b]	PS[c]	ED[d]	IR (kg/day)[e]	BW (kg)[f]	HR (Ha)[g]	WI (L/day)[h]
Bald eagle	9.80E–01	0.00E+00	2.00E-02	1.00E+00	7.44E-03	4.25E-02	9.00E+00	7.11E-03
Black tern	9.80E-01	0.00E+00	2.00E-02	6.50E-01	2.90E-03	1.00E-02	8.38E+00	2.70E-03
White-faced ibis	8.20E-01	0.00E+00	1.80E-01	2.50E-01	4.78E-03	2.15E-02	Aquatic	4.50E-03
Northern goshawk	9.80E-01	0.00E+00	2.00E-02	1.00E+00	1.61E-02	1.39E-01	2.18E+02	1.57E-02
Peregrine falcon	9.80E-01	0.00E+00	2.00E-02	1.00E+00	1.61E-02	1.39E-01	2.18E+02	1.57E-02
Trumpeter swan	0.00E+00	9.18E-01	8.20E-02	6.50E-01	2.92E-02	3.47E-01	Aquatic	2.90E-02
Townsend's big-eared bat	9.80E-01	0.00E+00	2.00E-02	2.50E-01	1.43E-03	4.65E-03	2.39E+00	7.88E-04
Pygmy rabbit (*Brachylagus idahoensis*)	0.00E+00	9.23E–01	7.70E–02	1.00E+00	4.27E–03	1.57E–02	3.00E–01	2.35E–03
Small-footed myotis (*Myotis subulatus*)	9.80E–01	0.00E+00	2.00E–02	2.50E-01	1.43E–03	4.65E–03	2.39E+00	7.88E–04
Sagebrush lizard (*Sceloporus graciosus*)	9.76E–01	0.00E+00	2.40E–02	1.00E+00	5.65E–05	6.61E–03	1.17E–01	0.00E+00

a. PP = percentage of diet represented by prey ingested (unitless). Herbivores = 0% prey, total PV = PV-PS; carnivores = 0% vegetation, total PP - PS): and omnivores =(1.00-PS)/2 for PP and PV.

b. PV = percentage of diet represented by vegetation ingested (unitless).

c. PS – percentage of diet represented by soil ingested (unitless). Soil ingestion from Beyer et al. (1994) and Arthur and Gates (1988)—(pronghorn, jackrabbit).

d. ED = exposure duration (fraction of year spent in the affected area) (unitless). Conventions: Residents—0.05–1.00 (birds and migratory and transient mammals) 1.00 (small mammals); breeding—0.05–0.65 (birds and migratory and transient mammals); summer visitors—0.05–0.25; winter visitors—0.05–0.25.

e. IR = ingestion rate [derived using allometric equations based on body weight (Nagy, 1987)] (kg/day).

f. BW = receptor-specific body weight (kg). Mammalian body weight primarily from Burt and Grossenheider (1976) and EPA Wildlife Exposure Factors Handbook (1993) for some species. Avian body weight from Dunning (1993).

g. Home ranges from Hoover and Wills (1987). "Aquatic" defaulted to an SUF of 1.0 (i.e., assumes 100% site use).

h. WI = water ingestion rates derived using allometric equation (Nagy, 1987).

- 1,4-Dichlorobenze
- 2-hexanone
- 2-methylnaphthalene
- Aluminum
- Antimony
- Aroclor-1254
- Aroclor-1260
- Arsenic
- Barium
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,j,i)perylene
- Beryllium
- Cadmium
- Chloromethane
- Chromium(III)
- Chromium(VI)
- Chrysene
- Cobalt
- Copper
- Cyanide
- Dichlorodifluoromethane
- Di(2-ethyl-hexyl)phthalate
- Fluoride
- Indeno(1,2,3-cd)pyrene
- Lead
- Manganese
- Mercury
- Naphthalene
- Nickel
- Phenanthrene
- Proprionitrile
- Selenium
- Silver
- Sodium
- Strontium
- Sulfate
- Sulfide
- Tetrahydrofuran
- Tin
- TPH
- Thallium
- Vanadium
- Vinyl Acetate
- Xylene
- Zinc

Many of the WAG 1 contaminants are metals. Soils represent the most concentrated source of metals in the terrestrial environment. Particulate matter readily sorbs metals, which may complex with various anions such as carbonates and sulfides, modifying their water solubility. Such sorption and complexation (typically) diminishes the bioavailability of metals in soils and sediments or aqueous systems (Adams et al. 1992).

The health risks posed by trace metals in soils are not determined solely by their quantity. A number of contaminant, environmental, and biological conditions and processes influence the accessibility and availability of metals to organisms, and hence their toxicological significance. First, speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of metal compounds. Second, the distribution coefficient between soil and water (K_d) depends upon both the properties of the metal and the composition of the soil. This coefficient also governs the bioavailability of a metal to organisms contacting the soil, with weakly bound metals highly bioavailable and more strongly bound metals less bioavailable. Other influential factors include: (1) the characteristics of the interface (e.g., lung, skin, intestine), (2) the reactivity of the metal with the interface, and (3) the concurrent presence of other metals or other substances that may stimulate or inhibit metal uptake.

Factors which influence the fate and transport (and thereby bioavailability) of the WAG 1 COPCs are presented in Sections 7.3.4 and 7.3.5, along with discussions of the ecotoxicological effects and derivation of TRVs for these contaminants.

7.3.2 Determining Exposure

Potential exposures for functional group, T/E, and C2 species were determined based on site-specific life history and feeding habits when possible. Quantification of group and individual exposures incorporated species-specific numerical exposure factors including body weight, ingestion rate, and fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Parameters used to model contaminant intakes by the functional groups are presented in Table 7-16. These values were derived from a combination of parameters that produced the most conservative overall exposure for the group. The functional group parameters in Table 7-16 represent the most conservative combination of percent prey, percent vegetation, percent soil, exposure duration, ingestion rate to body weight ratio, and home ranges from species within the functional group.

Each receptor's diet was assumed to be composed of percentages of two food types (i.e., percentages of either prey or vegetation) to simplify exposure calculations. For example, herbivorous animals are assumed to consume solely contaminated vegetation taken from the WAG 1 area. Vegetation is not broken into seeds versus vegetative parts to take advantage of the potential differences in plant part uptake. While this is a simplistic and conservative assumption, breaking down the diet of individual species within a functional group in more detail, while warranted, is beyond the scope of a WAG ERA. Most terrestrial receptors incidentally or directly ingest soil and the percent of soil ingested from that affected area was also estimated.

Exposure estimates were adjusted for the WAG 1 site areas by the use of site use factors (SUFs). The SUF is the WAG 1 site area [hectare (ha)] divided by the species' home range (ha) to a maximum of 1. Home ranges for the functional groups at WAG 1 are summarized in Table 7-16. However, many are unknown, and these are defaulted to a SUF of 1.0. A SUF of less than 1 indicates that the home range is larger than the area affected, and it is likely that these functional groups or T/E species consume prey, vegetation, and soil from unaffected areas.

Exposure duration (ED) is based on the migratory pattern of the receptors. This is determined using the status and abundance data compiled for site species (VanHorn et al. 1995). Five status and abundance categories are represented: resident, breeding, summer visitor, migratory, and winter visitor. For year-round residents, the ED is assumed to be 1 (i.e., receptors potentially spend up to 100% of the year on the assessment area). For species breeding onsite, the ED is assumed to be 0.65 (i.e., receptors potentially spend up to 65% of the year on the assessment area). For migratory summer and winter visitors, the ED is assumed to be 0.25 (i.e., receptors potentially spend up to 25% of the year on the assessment area). The most conservative ED duration is chosen from the functional group members to represent the functional group ED.

Food intake rates (grams dry weight per day) for passerine birds, nonpasserine birds, rodents, herbivores, all other mammals, and insectivorous reptiles were estimated using the following allometric equations (Nagy 1987). The equation for insectivorous reptiles was conservatively assumed to be applicable to the carnivorous reptiles (R322). Because different allometric equations may apply to different species within a group, the equations representative of all mammals and avians were used to calculate the ingestion rate (IR) for the functional groups. Exposure of each functional group was calculated using the best available estimates for species-specific exposure parameters. Each of the receptors was evaluated individually. Potential exposure for these species was determined based on the species' life history and feeding habits. Quantification of exposures used species-specific numerical exposure factors including body weight, ingestion rate, and fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Species parameters used to model intakes by the functional

groups are presented in Table 7-16. These values are derived from the various key species in the functional groups. The parameters in Table 7-16 are the maximum percent prey, percent vegetation, percent soil, exposure duration, the ratio of minimum IR to body weight, and home ranges for each functional group because these values were the most conservative. Percent soil ingestion rate values come from the *Wildlife Exposure Factors Handbook* (EPA 1993) and Beyer et al. (1994) and site specific data where available.

$$\text{Food intake rate} = 0.398\ BW^{0.850}\ \text{(passerines)} \tag{7-1}$$

$$\text{Food intake rate} = 1.110\ BW^{0.445}\ \text{(desert bird)} \tag{7-2}$$

$$\text{Food intake rate} = 0.648\ BW^{0.651}\ \text{(nonpasserines)} \tag{7-3}$$

$$\text{Food intake rate} = 0.583\ BW^{0.585}\ \text{(rodents)} \tag{7-4}$$

$$\text{Food intake rate} = 0.577\ BW^{0.727}\ \text{(herbivores)} \tag{7-5}$$

$$\text{Food intake rate} = 0.15\ BW^{0.874}\ \text{(desert mammals)} \tag{7-6}$$

$$\text{Food intake rate} = 0.013\ BW^{0.773}\ \text{(insectivorous reptiles)} \tag{7-7}$$

where BW = body weight in grams.

7.3.2.1 Exposure to Nonradiological Contaminants. The exposure equation used to calculate average daily intake is used to calculate the dose to functional group and T/E species. For example, dose (intake) in mg/kg body weight-day can be estimated using the following equation, as adapted from EPA's

$$EE_{tot} = \frac{[(PP \times CP) + (PV \times CV) + (PS \times CS)] \times IR \times ED \times SUF}{BW} \tag{7-8}$$

Wildlife Exposure Factors Handbook (EPA 1993):

where

EE_{tot} = estimated exposure from all complete exposure pathways (mg/kg body weight-day)

PP = percentage of diet represented by prey ingested (unitless)

CP = concentration of contaminant in prey item ingested (mg/kg)

PV = percentage of diet represented by vegetation ingested (unitless)

CV = concentration of contaminant in vegetation ingested (mg/kg)

PS = percentage of diet represented by soil ingested (unitless)

CS = concentration of contaminant in soil ingested (mg/kg)

IR = ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg

ED = exposure duration (fraction of year spent in the affected area) (unitless)

BW = receptor-specific body weight (kg)

SUF = site usage factor (site area divided by home range; cannot exceed 1) (unitless).

The concentration of contaminant in prey can be estimated using the equation:

$$CP = CS \times BAF \quad (7\text{-}9)$$

where

CP = concentration in prey item ingested (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

BAF = contaminant-specific bioaccumulation factor (unitless).

The concentration of contaminant in vegetation (CV) can be estimated using the equation:

$$CV = CS \times PUF \quad (7\text{-}10)$$

where

CV = concentration in vegetation (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

PUF = contaminant-specific plant uptake factor (unitless).

Contaminant-specific PUFs (Baes et al. 1984) and concentration factors (CFs) for nonradionuclide contaminants are presented in Table 7-17. CFs for metals were developed as discussed in Appendix H. The log of PUF and CFs for organics is estimated using 1.588-0.578 log K_{ow}, and -7.735 + 1.033 log K_{ow}, respectively (Travis and Arms 1988). Log partitioning coefficients (K_{ow}) were taken from the *Groundwater Chemicals Desk Reference* (Montgomery and Welkom 1990).

7.3.2.2 Uncertainty Associated with Functional Groups. The selection of receptor parameters was designed to ensure that each of the members of the functional groups was conservatively represented. Because all members of a functional group are considered similar, it is reasonable to assume that all members of a group will be equally exposed to site-related contaminants. Quantification of dose for each functional group is expected to provide sufficient data to assess the general condition of the ecosystem and to be adequately protective of the majority of species potentially inhabiting WAG 1. In addition, sensitive

Table 7-17. PUFs and concentration factors for WAG 1 nonradionuclide contaminants (unitless).

	PUF[a]	BAF[b] for insectivores	BAF for carnivores[c]	BAF for omnivores[d]
Inorganics[e]				
Aluminum	4.0E-03	1.0E+00	4.0E-03	1.0E+00
Antimony	2.0E-02	9.05E-01	6.0E-03	9.0E-01
Arsenic	4.0E-02	1.0E+00	4.0E-02	1.0E+00
Barium	1.5E-01	1.0E+00	1.5E-02	1.0E+00
Cadmium	5.5E-01	1.1E+00	1.9E+00	1.9E+00
Chromium(III)	7.5E-03	6.0E-02	2.0E-01	2.0E-01
Cobalt	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Chromium(VI)	7.5E-03	6.0E-02	2.0E-01	2.0E-01
Copper	4.0E-01	1.0E+00	2.0E-01	1.0E+00
Cyanide	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Fluoride	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Lead	4.5E-02	3.0E-01	6.0E-01	6.0E-01
Manganese	1.0E+00	1.0E+00	2.5E-01	1.0E+00
Mercury	9.0E-01	4.0E-01	7.0E-01	7.0E-01
Nickel	6.0E-02	1.0E+00	6.0E-03	1.0E+00
Selenium	2.5E-02	1.0E+00	2.5E-02	1.0E+00
Silver	4.0E-01	1.0E+00	4.0E-01	1.0E+00
Sodium	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Strontium	7.5E-02	1.5E+00	1.5E+00	1.5E+00
Sulfate	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Thallium	4.0E-03	1.0E+00	4.0E-03	1.0E+00
Tin	3.0E-02	1.0E+00	1.0E+00	1.0E+00
Vandium	5.0E-03	1.0E+00	5.0E-03	1.0E+00
Zinc	1.5E+00	1.0E+00	7.0E-01	1.0E+00
Organics[f]				
Aroclor-1254	1.3E-02	4.0E-04	4.0E-04	4.0E-04
Aroclor-1260	1.2E+01	1.3E-03	1.3E-03	1.3E-03
Benzo(a)pyrene[g]	1.2E-02	4.1E-04	4.1E-04	1.0E+00
Benzo(b)flouranthene	1.2E-02	1.0E+00	1.0E+00	1.0e+00
2-methylnaphthalene	1.6E-01	1.0E+00	1.0E+00	1.0E+00

Table 7-17. (continued).

	PUF[a]	BAF[b] for insectivores	BAF for carnivores[c]	BAF for omnivores[d]
Naphthalene	1.6E-01	5.3E-05	5.3E-05	1.0E+00
Phenanthrene	1.0E-01	7.6E-05	7.6E-05	1.0E+00
Aroclor	1.0E+00	1.26E-03	1.26E-03	1.26E-03
Tetrahydrofuran	1.0E+00	1.0E+00	1.0E+00	1.0E+00
TPH	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Xylene	5.0E-01	2.2E-05	2.2E-05	2.2E-05

a. PUF = Plant uptake factor, appropriate for use with AV100 and M100 functional groups.
b. Bioaccumulation factors (BAFs) for insectivores, appropriate for AV200 and M200 functional groups.
c. BAFs for carnivores, appropriate for AV300 and M300 functional groups.
d. BAFs for omnivores, appropriate for AV400 and M400 functional groups.
e. Values and literature (Appendix H) for inorganics come from Baes et al. (1984).
f. Values for organics come from allometric equations presented in Travis and Arms (1988).
g. PUF and BAFs for benzo(a)pyrene were used for benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene.

species are included in the list of receptors for which dose is calculated. Hence, uncertainty associated with the selection of receptor parameters is expected to minimally influence dose estimates.

7.3.2.3 Uncertainty Associated with the Ingestion Rate Estimation. Using food intake rates in dry weight/day may overestimate intake rates since dry weights will contain more contamination/unit vegetation. Intake (ingestion) estimates used for the terrestrial receptors are based upon data in the scientific literature, when available. Food ingestion rates are calculated by use of allometric equations reported in the Nagy (1987). Uncertainties associated with the use of allometric equations could result in either an over-estimation or under-estimation ingestion rate resulting in either an over-estimation or under-estimation of the true dose rate.

7.3.2.4 Uncertainty Associated with the Receptor Site Usage. The calculation of dose incorporated the probability that the receptors may use or inhabit each site. The SUF is defined as the affected area (ha) divided by the home range (ha) of the receptor. If a given receptor's home range is larger than the affected area, then it is reasonable to assume that the receptor may not spend 100% of its life within the site area. Incorporation of the SUF adjusts the dose to account for the estimated time the receptor spends on the site. The less time spent on the site, the lower the dose. Home ranges for several functional groups are unknown and in these cases the SUF equals 1. This may overestimate the potential exposure to these receptors.

7.3.2.5 Uncertainty Associated with the PUFs and BAFS. Using PUFs to estimate plant concentrations has the advantages that it is easy to use and requires minimum data inputs (i.e., the measured or estimated concentration of metal in soil and a PUF taken from the literature). A PUF of 0.01 indicates that the plant concentration should be 1/100th of the total concentration in soil. For the WAG 1 ERA, PUFs for metals are taken from Baes et al. (1984). Although preference is given to studies that reported the steady-state concentration of metals in plants at edible maturity, various soil properties are not considered and data for numerous plant species (both animal feeds and those consumed by humans) are

combined. However, root uptake of metals is a complex process that depends on various soil properties (e.g., pH, CEC, and organic matter content) as well as the metal and type of plant involved. Therefore, the use of generic or crop-specific PUFs taken from the literature may not accurately estimate the concentration of metals in plants for all environmental conditions and species that may occur in WAG 1. The PUFs for organics are estimated using the geometric mean regression equation (Travis and Arms 1988) and using log K_{ow} values. The reliability of estimated PUFs is directly related to the reliability of the K_{ow} values used for the organics. Since K_{ow} values can vary greatly, use of the regression equation (Travis and Arms 1988) to estimate a PUF for organics may over-estimate or underestimate the true dose for organics. There is a great deal of uncertainty associated with the BAFs used to calculate dose. Very few BAFs are available in the scientific literature because they must be both contaminant and receptor specific. BAFs used for metals are discussed in Appendix H. The regression equation (Travis and Arms 1988) was used to calculate BAFs for the organic contaminants at WAG 1. It is assumed that terrestrial receptors of concern accumulate metals and organics in a similar way and to a comparable degree as beef and dairy cattle. In the absence of specific BAFs, a value of 1 was assumed. This assumption could over-estimate or underestimate the true dose from the contaminant, and the magnitude of error cannot be quantified. The terrestrial receptors of concern for WAG 1 may accumulate organics to a much larger or smaller degree than beef and dairy cattle, and using the regression equation (Travis and Arms 1988) could therefore overestimate or underestimate the true dose from the COPCs. Also the use of BAFs as discussed in Appendix H could result in overestimating or underestimating dose to ecological receptors at the site in the absence of site-specific data.

7.3.2.6 Uncertainty Associated with Soil Ingestion. The exposure assessment incorporates the percentage of soil ingested by each representative of the functional groups. Although food ingestion rates have the greatest effect on intake estimates, soil ingestion rates could also influence intake rates and, therefore, dose estimates. The EPA Wildlife Exposure Factors Handbook (EPA 1993) and Beyer et al. (1994) were used to assign soil ingestion parameters to four of the 12 functional groups and the percent soil ingested was assigned to one species (Arthur and Gates 1988). Where information did not exist in the literature on soil ingestion rates for terrestrial biota, soil ingestion rates are assumed to be 2% of the food ingestion rate for all burrowing mammals and birds that consume whole terrestrial prey and 1% for all other receptors. Estimating the percent soil ingested may overestimate or underestimate the dose because the effect of the estimated values on the overall dose outcome is dependent on the concentration of contaminant in the media of concern.

7.3.3 Ecological Effects Assessment

Ecological effects assessment consists of three elements:

- Selecting QCE levels
- Developing AFs
- Developing TRVs.

The following sections contain a general description of the procedures of ecological effects assessment and a discussions of each of the three elements.

7.3.3.1 General Procedures of the Ecological Effects Assessment. A TRV is defined as a dose for a receptor (including sensitive subgroups such as taxa under regulatory protection) that is likely to be without appreciable risk of deleterious effects from chronic exposure. Application of toxicity data

derived from surrogate species introduces uncertainty into the risk assessment. The magnitude of this uncertainty depends largely on (1) the degree of taxonomic difference between the key and test species; (2) the conditions under which the toxicity data are obtained; and (3) the endpoint of interest [e.g., chronic lowest-observed-adverse-effect level (LOAEL) or no-observed-adverse-effect level (NOAEL)] and the endpoint measured (e.g., death). AFs are applied in the development of the TRVs in an attempt to offset the uncertainties associated with extrapolation of toxicity information from literature to site conditions.

The approach for TRV derivation used in the WAG 1 ERA was developed for use at the Rocky Mountain Arsenal Superfund site in Commerce City, Colorado (Ludwig et al. 1994), and is generally based on the EPA reference dose approach (Lewis et al. 1990). It is predicated on the development and application of AFs, which are extended to explicitly account for variations and uncertainties in data and necessary extrapolations from the data. The types of variation and extrapolation uncertainties explicitly quantified are as follows:

- Variation in sensitivity among the members of a receptor population
- Uncertainty in extrapolating data from one taxon to another
- Uncertainty in using various effect levels to estimate no-effect levels receptors
- The inability of any single study to adequately address all possible adverse outcomes in a wild receptor population.

The approach developed for the Rocky Mountain Arsenal Superfund Site (Ludwig et al. 1994) offers several distinct advantages. By carefully identifying the specific types of adjustments needed in the extrapolation, this method permits maximum resolution of what each adjustment is intended to achieve. It emphasizes consensual, data-quality-based development of values for specific AFs rather than defaulting to arbitrary factors. It clearly discriminates between "best estimates" of the values of individual factors and adjustment for overall uncertainty, including the uncertainty associated with the AFs themselves.

The TRV values used for aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, lead, magnesium, manganese, mercury, thallium, and vanadium for plants were taken directly from an Oak Ridge National Laboratory study on contaminants (Suter et al. 1993) and no AF values were assigned. These values presented in that paper are toxicological benchmarks for screening potential contaminants of concern for effects on terrestrial plants in soil. These values are for those contaminants potentially associated with DOE sites and were, therefore, appropriately used in the calculations for the INEEL.

Selecting QCEs—TRV development is initiated by reviewing the available toxicological literature and relevant databases for each contaminant and functional group members to identify QCEs from the best available study. Studies considering nonlethal endpoints and reporting NOAELs are selected, if available. Those studies reflecting reproductive competence are preferred because such endpoints are considered to best reflect the population-level impacts of greatest concern in the ERA. The following criteria are used to select QCEs:

- Experimental taxa should be as similar as possible to receptors at any applicable INEEL site(s), both physiologically and ecologically. For body size, feeding, and behavioral habits, anatomy, and physiology, the surrogate species should be matched as closely as possible to the receptors.

- Test exposure route and medium should be similar to that expected for receptors in the field. For most of the receptors at the INEEL, exposure media are limited to soil and dietary items (both animal and vegetable). Liquid intake is largely in the form of metabolic water. Dietary laboratory studies are, therefore, the most appropriate models for extrapolation. Gavage and drinking water studies will be considered if necessary, but reduce confidence in the applicability of the study.

- Long-term (preferably lifetime) exposures should be used, because they are closest to exposure patterns occurring in the field.

- Experimental endpoints should represent ecologically significant effects at the population level. In general, the loss of a few individuals of a species is unlikely to significantly diminish the viability of the population or disrupt the community or ecosystem of which the species is a part. As a result, the fundamental unit for ERA is generally the population rather than the individual, with the exception of T/E species (EPA 1992). In general, the most appropriate endpoints for ERA are reproduction, neurological function, and growth and development. For species under regulatory protection, TRVs are based on the most sensitive nonlethal endpoints referencing specifically to individuals.

- Doses within the NOAEL-LOAEL bracket should be identified. If these data are not available, the following dose levels (in decreasing order of preference) may be used: chronic-nonlethal-adverse-effect-level > no-effect-level > frank-effect-level (including lethality). The definition of adversity requires considerable analysis of the potential ecological significance of the effects reported. For example, elevated liver weight or enzyme induction could represent an adaptive response rather than toxic injury.

- Studies should be of high quality, which is defined as complete in design with adequate numbers of subjects and dose levels, lifetime duration, explicit analysis of experimental uncertainty, clear results, and well-justified conclusions.

If a single study cannot be selected (e.g., where only acute exposure, lethal endpoint studies are available), then an average of several studies of similar quality using the same or closely similar species may be used. In averaging, extreme outliers (defined as greater than two standard deviations away from the mean) are excluded. Where similar endpoints are observed in more than one study of similar quality, the lowest QCE should be used.

Information on the toxicological effects on mammalian receptors of the following contaminants was not located; therefore, these contaminations could not be evaluated for potential risk:

- 1,4-Dichlorobenzene

- 2-Hexanone

- Chloromethane

- Dichlorodifluoromethane

- Vinyl Acetate.

Information on the toxicological effects on avian receptors of the following contaminants was not located; therefore, these contaminations could not be evaluated for potential risk:

- Aroclor-1260
- Antimony
- Barium
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Chromium(VI)
- Chrysene
- Di(2-ethylhexyl)phtlate
- 2-Hexanone
- Indeno(1,2,3)pyrene
- 2-Methylnaphthalene
- Naphthalene
- Phenanthrene
- Proprionitrile
- Silver
- Sodium
- Strontium
- Sulfide
- Tin
- TPH
- Xylene.

Developing AFs—The seven AFs for extrapolation from experimental studies to field exposures at the INEEL are defined as follows:

I = intrataxon variability

R = intertaxon variability

Q_1 = risk assessors certainty that the COPC actually causes the critical effect in the receptor, and that it is an ecologically significant effect

Q_2 = extrapolation from short- to long-term exposure durations

Q_3 = extrapolation across endpoint types to estimate an NOAEL

U = any residual uncertainty in the data evaluation process and estimation of other AFs based on data quality, study design, and known but otherwise unaccounted for extrapolation issues

M = correction of differences in metal bioavailability between QCE studies where soluble salts are administered via drinking water and INEEL exposure conditions (i.e., metal species are encountered in soil and dietary items). This is not generally used for INEEL assessments.

Values for these AFs are set based on the quality of the selected study in particular and of the database in general. Other potentially influential factors include the ecological circumstances of the receptor, regulatory criteria and standards, background contaminant levels, and protection status. To

prevent needless overestimation of risk, the maximal AF product (all AFs multiplied together) is scaled to the overall extrapolation error observed in experimental studies designed specifically to determine the uncertainty in such extrapolations. In one study, (Barnthouse et al. 1990) the range of maximal uncertainty necessary to permit extrapolation of various kinds of toxicity data for various taxa of finfish at the population level was quantified. The types of toxicity data used included studies involving particular species of interest and other species, for acute, partial life-cycle, and full life-cycle exposures. The range of maximal uncertainty varied with the type of data used, and ranged from approximately 200 to 400 (Barnthouse et al. 1990). It is assumed that the degree of variability observed among fish taxa is similar to that occurring among other vertebrate taxa.

Based on a systematic review of all available information (Ludwig et al. 1994), a simple, relative scale is developed consisting of "low," "medium," and "high" rankings for each AF, with adjustments made of the basis of specific inherent uncertainty or availability in the particular extrapolations. The quantitative valuation of this scale is designed to be constrained by an upper bound in the range of 200 to 400, and use the most plausible values for each AF.

Specific values for these AFs and a brief description of criteria for their use are presented in Table 7-18. Values for all AFs except Q_1, and M are set at 1 (low), 2 (medium), and 3 (high), with lower values generally representing greater confidence that the QCEs correspond well with "safe" doses for receptors. The factor Q_1, which expresses the degree of certainty that the experimental effect will not occur in the field or is not of ecological significance, runs on a positive scale equivalent where 0.1 represents high certainty that the effect either does not occur in the receptor or is ecologically irrelevant, 0.5 represents moderate certainty that the effect does not occur or is irrelevant, and 1 represents reasonable certainty that the effect will occur in the receptor species and is ecologically significant. The medium of exposure factor gram M is set at 1 if the medium of exposure in the QCE study is similar to field exposure media at this site (i.e., primarily food and soil ingestion). However, because a number of toxicological studies for metals used soluble salts in drinking water as a means of exposure, and both the contaminant species and exposure matrix tend to maximize metal absorption (e.g., Steele et al. 1990; Griffin and Turck 1991; Witmer et al. 1991), M may be set at 0.5 to conservatively represent the significantly lower bioavailability of the metal species associated with soils and dietary items in the natural environment. Thus, the maximum product of the seven AFs is 243. This AF maximum represents the extent to which valid extrapolation of the data can be applied across experimental protocols or among taxa. More detailed information on the definition and valuation of these factors is available from the Rocky Mountain TRV study (Ludwig et al. 1994).

Developing TRVs—The third element in ecological effects assessment is the derivation of TRVs. TRVs were derived for each functional group by selecting the experimental study with the most appropriate QCE for that chemical and assigning numeric values for all AFs to account for uncertainties associated with extrapolation across species and exposure conditions.

The algorithm used for developing a TRV is:

$$TRV = \frac{QCE}{AF} \qquad (7\text{-}11)$$

Table 7-18. AF values and criteria for their use in developing TRVs for the INEEL.

Adjustment factor	Qualitative ranking	Value	Criteria
I	Low	1	Variability is low
	Medium	2	Variability is moderate or average
	High	3	Variability is high, or information on variability is inadequate
R	Low	1	Test organism and functional group, T/E, and C2 species are in same taxonomic order and trophic category
	Medium	2	Test organism and functional group, T/E, and C2 species are in same trophic category but may be in different taxonomic order
	High	3	Test organism and functional group, T/E, and C2 species are in different trophic categories and taxonomic order
Q_1	Low	0.1	Experimental endpoint is highly unlikely to occur in the field
	Medium	0.5	Experimental endpoint is moderately unlikely to occur in the field
	High	1	Experimental endpoint is likely to occur in the field
Q_2	Low	1	Study was of chronic duration
	Medium	2	Study was of subchronic duration
	High	3	Study was of acute duration
Q_3	Low	1	NOAEL
	Medium	2	LOAEL
	High	3	Adverse-effect level or frank-effect level
U	Low	1	High quality studies
	Medium	2	Studies of reasonable quality
	High	3	Studies with flawed design or incomplete information
M	—	0.5	Soluble metal salt administered in drinking water
	—	1	Exposure medium comparable to those at the INEEL

where

QCE = quantified critical exposure level

AF = $[I] \times [R] \times [Q_1] \times [Q_2] \times [Q_3] \times [U] \times [M]$.

Information used to derive TRVs for nonradioactive inorganic and organic contaminants is summarized in this section. A summary of TRVs for each contaminant/functional group/sensitive species combination is presented in Appendix G for mammalian and avian receptors. Table G-1 summarizes the TRVs for mammalian functional groups and unsensitive species. A summary of the TRVs for avian functional groups is contained in Table G-2. Shading in Tables G-1 and G-2 corresponds to the TRVs chosen for each functional group. Using the most appropriate study, when the test organisms and the receptor were in the same taxonomic order and trophic category (R = 1), the corresponding TRV was chosen, as shown in heavier shading. When the test organism and the functional group are in the same trophic category an R = 2 AF is used. Otherwise, the most appropriate TRV developed using R = 3 was used. Little information was found describing the effects of COPCs on reptilian, invertebrate, or terrestrial plant receptors. When available, that information is summarized in Sections 7.3.5 and 7.3.7. Development of TRVs for radionuclides is described in Section 7.3.7.

7.3.4 Development of TRVs for Inorganic Contaminants of Potential Concern

This section contains summaries of the information used in determining the TRVs for the inorganic contaminants for which toxicological studies were located as follows:

- Arsenic
- Chromium
- Copper
- Fluoride
- Lead
- Manganese
- Mercury
- Sulfate
- Thallium.

The development of TRVs for the studies identified for each COPC is contained in Appendix G.

Many of the inorganic contaminants are metals. Soils represent the most concentrated source of metals in the terrestrial environment. The health risks posed by trace metals in soils are not determined solely by their quantity. A number of contaminant, environmental, and biological conditions and processes influence the accessibility and availability of metals to organisms, and hence their toxicological significance. First, speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of metal compounds. Second, the distribution coefficient between soil and water (K_d) depends on both the properties of the metal and the composition of the soil. This coefficient also governs the bioavailability of a metal to organisms contacting the soil, with weakly bound metals highly bioavailable and more strongly bound metals less bioavailable. Other influential factors include (1) the characteristics of the interface (e.g., lung, skin, intestine), (2) the reactivity of the metal with the interface, and (3) the concurrent presence of other metals or other substances that may stimulate or inhibit metal uptake.

Arsenic (CAS No. 7440-38-2). Arsenic is a metalloid element that is widespread in all environmental media, making up about 0.0005% of the earth's crust. Arsenic is commonly present in living organisms and is constantly being oxidized, reduced, or metabolized. Many arsenic compounds are readily solubilized in soil, making them available for plant uptake or for reduction by organisms or chemical interactions. Biological uptake of arsenic results in measurable quantities of reduced or methylated arsenic forms. Arsenic occurs naturally in all environmental media. Arsenic has four valence states: -3, 0, +3, and +5. Arsines and methylarsines, which are characteristic of compounds in the -3 state, are unstable in air. Most arsenicals degrade to yield arsenate, although arsenate may form under anaerobic conditions. Biotransformation of these compounds may occur and yield volatile arsenicals. The dominant form of arsenic present in aerobic soils is As^{+5}, while As^{+3} is the primary species in anaerobic soils. Inorganic arsenic is more mobile than organic arsenicals and thus is more likely to leach into surface or groundwaters. Trivalent species are generally more toxic, more soluble, and more mobile than pentavalent forms. Soil microbes can metabolize arsenic to volatile arsine forms. The half-life of arsenic in soil is estimated to be 6.5 years for arsenic trioxide to 16 years for lead arsenate. Soils with high organic matter content, low pH, low phosphate, and low mineral content readily sorb arsenates. In air, most arsenic particulates contain inorganic arsenic compounds, particularly As^{+3} compounds (Eisler 1988a).

At relatively low levels, arsenic stimulates growth and development in several plant species (Eisler 1988a). The bioavailability of arsenic depends on several factors including pH, soil texture, fertility level, and plant species. Inorganic arsenate is readily taken up by plants via the phosphate carrier mechanism. Therefore, plants tend to have a poor ability to distinguish arsenate from phosphate. In general, arsenic is most available to plants grown in coarse soils having little colloidal material and a low ion-exchange capacity. Conversely, fine soils high in clay, organic matter, iron, calcium, and phosphate tend to retard the bioavailability of arsenic to plants (NRCC 1978). The accumulation of arsenic in plants tends to be directly correlated with the amount of arsenic in the dissolved fraction versus total arsenic concentrations (NRCC 1978).

The potential toxicity of arsenic to any organism is dependent on its chemical form. Inorganic arsenicals are generally more toxic than organic arsenicals, and trivalent forms are more toxic than pentavalent forms. Toxicity is related to aqueous solubility, and the order of toxicity (from greatest to least) is arsines > inorganic arsenites > organic trivalent compounds > inorganic arsenates > organic pentavalent compounds > arsonium compounds > elemental arsenic (Eisler 1988a).

Chemical properties contributing to arsenic's toxicity include its ability to bind to protein sulfhydryl groups and to substitute for phosphorus in some biochemical reactions. These chemical properties may also be responsible for arsenic's apparent essentially in several mammalian species (e.g., Frost 1983; Uthus 1992). In fact, arsenical feed additives are used to promote growth in a number of agricultural species (Eisler 1988a). Recent studies have suggested that arsenic has a physiological role in the formation of various metabolites of methionine metabolism (Uthus 1992). The arsenic requirement for growing chicks and rats is approximately 25 mg/kg diet (Uthus 1992). Species differences in the pharmacokinetic disposition of arsenic have significant effects on their sensitivity to its toxic effects. In addition, animals exposed to sublethal levels of arsenic can develop tolerance to subsequent exposures (Eisler 1988a).

A subacute study using domestic sheep was documented (Eisler 1988a) in which an NOEL endpoint using 2.3 mg/kg-day was reported. An LOAEL of 1.5 mg/kg-day was reported in a chronic study using sodium arsenate in rats (Byron et al. 1967). The data did not show a good dose-response curve in the low-dose range. This study was used in the development of TRVs for rats.

The National Academy of Sciences reported a LD_{50} of 39 mg/kg-day using sodium arsenite in mallards.

The recommended screening benchmark concentration for phytotoxicity in soil for arsenic of 10 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Cadmium (CAS No. 7440-43-9). Cadmium is a silver-white, blue-tinged, lustrous metal. It is insoluble in water, although its chloride and sulfate salts are relatively soluble in water. The availability of cadmium in soils depend upon soil pH, cation exchange capacity, chemical speciation, and many other factors. Adsorption and desorption process tend to influence the concentration of cadmium in natural waters. Adsorption and desorption occur rapidly in soil. Cadmium tends to remain in the upper portion of the soil profile. Its bioavailability depends on adsorption/desorption rates, pH, and speciation. Cadmium uptake by plants is influenced by the concentration of calcium, sulfides, and sulfites present in the soil. Calcium and cadmium are considered to have the same uptake site; thus, levels of calcium present in soil could limit the amount of cadmium taken up by plants. Cadmium availability to plants is affected by redox potential and pH. Humus-bound and sorbed cadmium contribute to the plant available pool. Availability may be reduced by higher organic matter content and higher cation exchange capacity (Eisler 1985).

Cadmium is found naturally in the environment due to chemical weathering of rocks. It is generally found in soil as the free cadmium compounds (ATSDR 1993). There is no evidence that cadmium is biologically essential (Eisler 1985). Cadmium is not reduced or methylated by microorganisms (ATSDR 1993). Birds and mammals are comparatively resistant to cadmium toxicity as compared to aquatic species. Sublethal effects of cadmium include growth retardation, anemia, and testicular damage (Hammons wt al. 1978) as cited in Eisler (1985). Cadmium readily reacts with sulfhydral groups and may inhibit enzymatic reactions (Eisler 1985). Bioaccumulation of cadmium has been reported in aquatic systems, however, only lower trophic levels are reported to exhibit biomagnification (Eisler 1985). Accumulation of cadmium in avian species has been reported in liver and kidneys.

TRVs were developed using a multigeneration rat reproduction study by Wills et al (1981) in which a LOAEL of 5 mg/kg-day was established.

Chickens exposed to cadmium in the diet had reduced growth rates in a study by Pritzl et al. (1974). This study was used to derive a TRV for avian receptors. Behavioral changes were observed in young American black ducks when parents were fed 4 ppm cadmium for 4 months before egglaying (Heinz and Haseltine 1983; as cited in Eisler 1985).

For invertebrates, a study on the toxicity of cadmium nitrate to the isopod (*Porcellio scaber*) was used to develop a TRV. The study reports a critical concentration of 100 µg/g cadmium in food on a dry weight basis for reproduction (Hopkin and Hames 1994).

The recommended screening level toxicological benchmark for phytotoxicity in soil of 2 mg/kg for cadmium was used as the TRV (Suter et al. 1993).

No information on the toxicological effects of cadmium on reptilian receptors was located.

Chromium (CAS No. 7440-47-31). Chromium is a multivalent element and can exist in the +2, +3, and +6 oxidation states. The latter two, chromium (III) and chromium (VI), are the most stable in the environment. In soils and sediments, chromium is influenced by oxidation and reduction reactions and can be adsorbed on the mineral and organic exchange complex or exist as a coating in iron and manganese

hydrous oxide particles. Moreover, chromium may remain in solution in the pore water phase, or may become chelated by an organic liquid or precipitated (Adriano 1986; Callahan et al. 1979). The sorption of chromium (VI) by hydrous metals oxides and other soil mineral components decreases as pH levels increase. The presence of other anions (e.g., sulfate and phosphate) significantly affects the extent of adsorption by competing for adsorption sites. Formation of ion pairs, such as dissolved calcium chromate, may also reduce the extent of adsorption. In contrast to chromium (VI), the sorption of chromium (III) increases as pH units increase. In general, it appears from laboratory studies that chromium (III) is adsorbed more strongly than chromium (VI). Organic material may also be an important adsorbent in sediments and soils. Slight enrichment of chromium occurs in the humic fraction. Typically, in normal, well-drained soils, the great majority of chromium is in the form of chromium (III).

Chromium (VI) is generally more toxic than chromium (III). Although most chromium (VI) is reduced to chromium (III) in the acidic environment of the stomach (Donaldson and Barreras 1966), chromium (VI) compounds are absorbed significantly more efficiently from the gastrointestinal tract (2 to 10% of administered dose) than chromium (III) compounds (Outridge and Scheuhammer 1993). Once absorbed, chromium (VI) is quickly reduced to the trivalent form. The damaging effects of chromium (VI) are caused by its greater membrane permeability, which allows it to cross biological membranes and oxidize cellular components not normally accessible to chromium (VI). As a result, the differences in systemic toxicity are primarily attributable to differential solubilities and absorption rates of the two valence states (Franchini and Mutti 1988).

The mobility of chromium (VI) and the limited supply of extracellular reductants causes chromium (VI) to be distributed more widely in the body than chromium (III). The intracellular reduction of chromium (VI) to chromium (III) generates unstable intermediate chromium (V) and chromium (IV) ions, active oxygen species (hydroxyl and superoxide radicals, single oxygen), and thiyl and organic radicals that are responsible for the cytotoxicity, mutagenicity, and carcinogenicity of the hexavalent form (reviewed by Manzo et al. 1992; Cohen et al. 1993; O'Flaherty 1993; Outridge and Scheuhammer 1993).

Chromium exhibits a pattern of biominification rather than biomagnification in ecological food webs. Because the speciation of chromium (VI) taken up by plants is poorly understood, it is assumed to be the primary form of exposure to herbivores. However, chromium (VI) is immediately converted to chromium (III) in animal tissues. Therefore, carnivorous receptors will be primarily exposed to the less toxic trivalent form. Development of TRVs based on chromium (VI) for receptors higher in the food chain is thus highly conservative, and will tend to overestimate chromium-related risk to these receptors.

In a study of chromium toxicity (Rosomer et al. 1961), subchronic NOAEL of 100 mg/kg in the diet for chickens were reported. This information is used to estimate the TRV for avian functional groups.

Pregnant female mice receiving 250 mg/L potassium dichromate in drinking water throughout gestation showed no clinical signs of toxicity, but produced significantly fewer viable offspring (Trivedi et al. 1989). In the dog, 6 mg/L in drinking water (approximately 0.3 mg/kg/day) was a chronic NOAEL [Steven et al. 1976 (cited in Eisler 1986)]. A similar level was without observable effects in a study of chronic toxicity (Anwar et al. 1961). Based on these results, TRVs were derived for mammalian functional groups.

Copper (CAS No. 7440-50-8). Copper is one of the least mobile of the trace elements and tends to be uniformly distributed in the soil horizon. Soil parameters that influence copper availability include pH, CEC, and organic matter content. Persistence of copper in soils is caused by binding to organic matter, the formation of oxides with iron and manganese, the presence of clay minerals, and soil pH. A pH of 6 or less

increases the mobility and availability of copper in soil. Copper is one of the trace elements most extensively complexed by humic materials. Most copper is readily available to plants when the soil pH is below 6, especially in soils with low organic matter and humic material content. Sulfides, which may prevail in soils under reducing conditions, effectively precipitate copper, thereby reducing the bioavailable amount of copper. Biogenic ligands bind with copper, resulting in the precipitation and sorption of copper. Copper is one of seven essential plant micronutrients. Copper in soil tends to strongly bind with organic matter, which limits it's availability for uptake by plants.

Copper is widely distributed in nature and is an essential element for (1) the normal function of several critical enzymes and (2) the utilization of iron. Copper deficiency is, therefore, usually a greater health concern than copper excess. Copper absorption in the gastrointestinal tract is normally regulated by body stores. Absorbed copper is transported to the liver, where it may be incorporated into ceruloplasmin (a copper transport and donor molecule) and excreted into the plasma, stored as metallothionein or in lysosomes, or excreted via the bile (reviewed by Nederbragt et al. 1984).

Depressed food intake, body-weight gain, egg number and weight, and organ weights are associated with copper excess in poultry (Stevenson and Jackson 1981). The pair-feeding study was conducted to determine whether these effects were associated with direct toxicity or the accompanying marked reduction in food intake (Stevenson and Jackson 1981). Body weight, food intake, organ weights; egg production; egg weight; clinical chemistry parameters; and organ copper, iron, and zinc concentrations were monitored in laying hens fed varying concentrations of copper in their diet for 6 weeks (Stevenson and Jackson 1981). A NOAEL of 24 mg/kg/day was identified and used to develop TRVs for avian functional groups.

High doses of copper have caused liver and kidney damage as well as anemia in a number of species. It has been observed that the stomach is also a target in rats and mice (Hebert et al. 1993). This well-designed subchronic feeding study examined histopathology, clinical pathology, reproductive toxicity, and tissue metal accumulation in males and females of both species. A QCE of 66 mg/kg/day (NOAEL) was identified from this study and used to develop mammalian TRVs. A chronic study of young calves (Cunningham 1946) confirms that young calves are susceptible to chronic doses of copper. The QCE from this study is 1.1 mg/kg-day.

A mammalian TRV was also derived from a chronic feeding study in mink (Aulerich et al. 1982). The purpose of this study was to determine whether copper supplements would improve growth and survival. Endpoints examined included the effects on growth, blood chemistry, reproductive performance, and kit survival and development. The QCE from this study is a NOAEL of 12.9 mg/kg/day.

The recommended screening benchmark concentration for phytotoxicity in soil for copper of 40 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Fluoride (CAS No. 16984-48-8). Inorganic fluorides are generally highly irritating and toxic. Acute effects resulting from exposure to fluorine compounds are due to HF. Chronic fluorine poisoning, or "fluorosis," occurs among numbers of cryolite, and consists of a sclerosis of the bones caused by a fixation of the calcium by the fluorine. There may also be some calcification of the ligaments. The teeth are mottled, and there is osteosclerosis and osteomalacia. Large doses can cause very severe nausea, vomiting, diarrhea, abdominal burning and cramp-like pains. Fluoride is not taken up by the thyroid and does not interfere with iodine uptake. It can cause or aggravate attacks of asthma and severe bone changes, making normal movements painful. Some signs of pulmonary fibrosis have been noted (Sax and Lewis 1987).

The reproductive effects of fluoride administered orally in the diet of minks was studied (Aulerich et al 1987). Five dose levels were administered. Fluoride up to 229 ppm had no adverse effects on reproduction. Survivorship of kits in the 385 ppm group was significantly reduced. These doses were considered to be NOAELs and LOAELS, respectively. Because the study considered exposure over 382 days including critical life stages (reproduction), these doses were considered to be chronic. A NOAEL of 31.37 mg/kg/d was established.

The effects of fluoride administered to the screech owl orally in the diet for a period of 5 to 6 months were studied (Pattee et al. 1988). The fertility and hatching success were significantly reduced by 232 ppm fluorine in the diet, 56.5 ppm fluorine in the diet had no adverse effect. Because the study considered exposure during reproduction, these doses were considered to be chronic. A NOAEL of 7.8 mg/kg/d was established.

Lead (CAS No. 7439-92-1). Lead is a ubiquitous trace constituent in rocks, soils, plants, water, and air, with an average concentration of 16 mg/kg in the earth's crust (Eisler 1988b). Lead has four stable isotopes: Pb-204 (1.5%), Pb-206 (23.6%), Pb-207 (22.6%), and Pb-208 (52.3%). Lead occurs in four valence states: elemental (Pb°), monovalent (Pb^{+}), divalent (Pb^{+2}), and tetravalent (Pb^{+4}). In nature, lead occurs mainly as Pb^{+2} and is oxidized to Pb^{+4}. Metallic lead is relatively insoluble in hard waters. Some lead salts are somewhat soluble in water. Of the organoleads, tetraethyllead and tetramethyllead are the most stable and are highly soluble in many organic solvents but are fairly insoluble in water. Both undergo photochemical degradation in the atmosphere to elemental lead and free organic radicals. Organolead compounds are primarily anthropogenically-produced (Eisler 1988b).

Lead is neither essential nor beneficial to living organisms. Lead affects the kidney, blood, bone, and central nervous system. Effects of lead on the nervous system is both functional and structural. Lead toxicity varies widely with the form and dose of administered lead. In general, organolead compounds are more toxic than inorganic lead. In nature, lead occurs mainly as divalent, Pb^{2+}. Ingestion of lead shot by regulatory waterfowl is a significant cause of mortality in these species.

Hatchlings of chickens, quail, and pheasants are relatively tolerant to moderate lead exposure (Eisler 1988b). There was no effect on hatchling growth of these species at dietary levels of 500 mg/kg or on survival to 2,000 mg/kg lead (Hoffman et al. 1985 as cited in Eisler 1988). For avian herbivores, a TRV was estimated using a study of mallards (Dieter and Finley 1978). Altricial species are generally more sensitive to lead than precocial species (Eisler 1988b) of avian insectivores. An oral study using European starlings (Osborn et al. 1983) was used to generate a TRV for trimethyllead chloride. Because organic lead compounds are generally more toxic than inorganic lead, the TQs generated using this TRV should be interpreted with caution. American kestrel (*Falco sparverius*) exposed to 50 mg/kg/day metallic lead in diets did not exhibit effects on survival or reproductive success (Colle et al. 1980). Using these studies, TRVs were developed for avian functional groups.

Studies using rats administered lead in drinking water (Kimmel et al. 1980), of lead toxicity in calves (Zmudzki et al. 1983), and using dogs (Demayo et al. 1982) were used to develop TRVs for mammalian receptors.

A study on the toxicity of lead nitrate to the isopod (*Porcellio scaber*) reports a critical concentration of 2,000 g/g lead in food on a dry weight basis for reproduction (Hopkin and Hames 1994).

The recommended screening benchmark concentration for phytotoxicity in soil for lead of 50 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Manganese (CAS No. 7439-96-5). The transport and partitioning of manganese are influenced by the solubility of the particular form present, which, in turn, is determined primarily by the pH oxidation and reduction potential. Manganese may exist in one of four oxidation states: 2+, 3+, 4+, and 7+. Divalent manganese (Mn^{+2}) exists mostly in waters with a pH of 4 to 7. The likelihood that soluble manganese compounds will sorb to soils is affected primarily by the CEC and the organic matter content of the soil. Soil sorption can vary by as much as five orders of magnitude depending on soil conditions. The oxidation state of manganese in soil may be altered by microbial populations (ATSDR 1992a). Manganese affects the central nervous system in humans. However, it is important to recognize the substantial difference in species requirements for manganese. Toxic levels of manganese in humans do not meet the nutritional requirements of rats (EPA 1994).

The bioavailability of different forms of manganese varies considerably depending on different exposure conditions. There is potentially higher bioavailability of manganese from drinking water than food. It is also important to recognize that various dietary factors as well as the form of manganese can have a significant bearing on the dose absorbed from the gastrointestinal tract. For instance, many constituents of a vegetarian diet (e.g., tannins, oxalates, phylates, fiber, calcium, and phosphorus) have been found to inhibit manganese absorption presumably by forming insoluble complexes in the gut. Thus, herbivores are more likely to be resistant to manganese toxicity. Also, the form of manganese can significantly influence toxicity. For example, mice receiving the two soluble forms of manganese (chloride and acetate salts) were found to gain significantly less weight than controls, while mice consuming the insoluble forms of manganese (carbonate and dioxide salts) appeared to actually gain slightly more weight than controls.

The manganese requirements vary considerably between species. In terms of dietary concentration (ppm), the requirements of young animals have been estimated as follows:

- dog, 4.5
- rabbit, 8.5
- pig, 4
- calf, 40
- sheep, 30
- rat, 50
- chick, 55
- turkey, 55 (NAS 1980).

A study reporting the minimum manganese requirements in chickens was used to derive a TRV of 2.9 mg/kg/day. Guinea fowl were found to have reduced hatchability and increased deformed embryos when fed diets deficient in manganese (Offiong and Abed 1980). A dietary reproduction study in rats exposed to 250 ppm manganese (13 mg/kg/day) was used to develop a TRV of 1.1 mg/kg/day (Laskey et al. 1982).

No information on the toxicity of manganese to reptiles or invertebrates was located.

The recommended screening benchmark concentration for phytotoxicity in soil for manganese of 500 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Mercury (CAS No. 7439-96-5). Mercury exists in the environment in three oxidation states: the element itself, +1 (mercurous) state, and +2 (mercuric) state. The factors that affect which species dominates in an environment are the redox potential and the pH of the system. Particle-bound mercury can be converted to insoluble mercury sulfide, which can be bioconverted into more soluble or volatile forms that may reenter the atmosphere or be taken up by biota and bioaccumulated in the terrestrial food chain. Mercury forms many stable organic complexes that generally are more soluble in organic matter than in water. Inorganic and organic particles strongly sorb mercury. Mercury can be transformed in the environment by biotic and abiotic oxidation and reduction, bioconversion of organic and inorganic forms, and photolysis. Mercury can be strongly concentrated by living organisms (Callahan et al. 1979). The chemistry of mercury in the environment is complex, not only because of its various oxidation states but also because of biotic and abiotic methylation and demethylation processes, complexation with organic and inorganic ligands, and the differential solubility and volatility of various forms. As speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of mercury compounds, lack of knowledge of the state of the mercury in INEEL soils is a large source of uncertainty in both exposure assessment and TRV development.

Although the generally more toxic organic forms of mercury are unlikely to persist in the environment, they (in particular, methylmercury) may be formed in biotic tissues and are known to biomagnify through ecosystems, particularly aquatic systems (reviewed by Wren 1986; Scheuhammer 1987). Thus, to ensure that mercury TRVs for the WAG ERA are protective of receptors at all levels of ecological organization, TRVs are developed from studies investigating the toxic effects of organic mercurials. It is noted that this measure is highly conservative and will tend to overestimate risks for receptors lower in the food web because the majority of mercury in soil and plants (i.e., the majority of exposure to plants and soil-dwelling and herbivorous animals) is expected to be inorganic.

Because of its chemical stability and lipophilicity, methylmercury readily penetrates the blood-brain barrier. The central nervous system is thus a major target organ in both mammals and birds. However, reproductive effects have been reported at even lower doses. Methylmercury can be converted to inorganic mercury both in tissues and by microflora in the gut. The homolytic cleavage of the mercury-carbon bond leads to generation of reactive intermediates, e.g., methyl and metal radicals, which cause cellular damage (reviewed by Wren 1986; Scheuhammer 1987; Manzo et al. 1992).

The effects of mercury on avian herbivores, insectivores, and carnivores were evaluated as follows. For herbivores, the effects of organic mercury compounds on galliformes (domestic chickens, quail, pheasants) have been investigated by several groups. However, no study was reviewed that identified an NOAEL. The lowest LOAEL for relevant endpoints (reproductive success) of several similar studies was found in a study of the effects of mercury to birds (Fimreite 1979). Reduced egg production, shell thickness, and hatchability in pheasants fed seed treated with organomercurial fungicide were observed. This study was selected over others because of its use of a wild species and lower dose levels. A TRV was derived from this study.

Three goshawks were fed a diet of chickens that had eaten wheat dressed with an organomercurial fungicide (Borg et al. 1970). Their tissues contained 10 to 40 ppm of mercury, mostly as methylmercury. The hawks died after 30 to 47 days; their total mercury intake was about 20 mg/bird.

Two studies examined the effects of subchronic methylmercury exposure on the reproductive competence of male and female rats (Khera and Tabacova 1973; and Khera 1973). The NOAEL identified for both sexes was 0.25 mg/kg/day. Much less information is available regarding methylmercury toxicity to herbivores. In a study of acute methylmercury toxicity in mule deer (*Odocoileus hemionus hemionus*) 17.88 mg/kg was said to be the LD_{50} (Eisler 1987a). A number of studies have examined the effects of chronic methylmercury ingestion on carnivorous mammals, particularly cats (e.g., Albanus et al. 1972; Charbonneau et al. 1976; Eaton et al. 1980) and mink (e.g., Aulerich et al. 1974; Wobeser et al. 1976; Wren et al. 1987). The chronic toxicity of cats study by was considered superior to other available studies because of its long duration (2 years), use of relatively large group sizes, detailed examination of endpoints, identification of both no-effect and effect levels, and administration of mercury via both contaminated fish and addition to diet (Charbonneau et al. 1976).

A TRV of 0.3 mg/kg was assigned for mercury for terrestrial plants based on the toxicological benchmark (Suter et al. 1993).

Sulfate. Sulfates are generally of low toxicity. Several studies indicate no adverse effects when sulfate compounds are administered (Brown and Gamatero 1970; Sasse and Baker 1974; Paterson et al. 1979) and others that list the effects of loose feces and decrease intake (Bird 1972; L'Estrange et al. 1969). These five studies were conducted using chickens, pigs, and sheep. One study listed an LD_{50} for a single-dose injection of sodium sulfate monohydrate in mice of 45.6 mg/kg/d (Nofre et al. 1963). To develop TRVs, studies identified for sodium sulfate were used.

Thallium (CAS No. 7440-28-0). Thallium is a nonvolatile heavy metal element that is not used extensively by industry and is mainly introduced into the environment as a waste product of other metals. Thallium can exist in the atmosphere as an oxide, a hydrazide, a sulfate, or a sulfide. Thallium is present in mono- or trivalent forms in the environment. Thallium (III) forms some organometallic compounds and thallium (I) forms relatively few complexes with the exception of those with halogen, oxygen, and sulfur ligands. Thallium can be removed from solution by adsorption onto clay minerals, bioaccumulation, or (in reducing environments) precipitation of the sulfide. Increased pH values have been found to produce extensive thallium-humic acid interactions while lowering thallium-inorganic interactions. Thallium may be bioconcentrated by living organisms (Callahan et al. 1979). Thallium (I) is more stable and resembles the alkali metal cations in many of its chemical properties. Thallium (III) forms many organic compounds (Zitko 1975), the toxicity of which has been little explored.

Thallium is slightly more acutely toxic to mammals than mercury. The similarity between kinetic profiles of inorganic trivalent and monovalent thallium species suggests that they are converted in vivo to one chemical form, probably monovalent thallium (Sabbioni et al. 1980). Isomorphic with potassium, thallium (I) is readily absorbed and distributed throughout the body, and can substitute for potassium and other monovalent cations in enzymatic reactions. The affinity of thallium (I) for enzymes is 10 times higher than that of potassium, which may cause the observed toxic effects (Zitko 1975). Thallium (I) uncouples oxidative phosphorylation, adversely affects protein synthesis, and inhibits a number of enzymes including alkaline phosphatase and succinic dehydrogenase (Zitko 1975). Thallium is also toxic to plants, inhibiting chlorophyll formation and seed germination.

A study in the 1930s of the acute toxicity of thallium sulfate in game birds including quail (Shaw 1933) formed the basis for the TRV for these functional groups. In a study of the acute toxicity of thallium sulfate in three immature golden eagles *(Aquila chrysaetos),* the acute oral LD_{50} was estimated to be between 60 and 120 mg/kg (Bean and Hudson 1976). Using the lower end of this range as the QCE, a TRV for raptorial birds at the INEEL was derived.

Rats exposed to thallium in their drinking water have shown effects on various neurological (Manzo et al. 1983; Rossi et al. 1988) and reproductive (Formigli et al. 1986) endpoints. Because of the clear ecological relevance of reproductive impairment, a QCE was selected from the study of thallium-induced testicular toxicity (Formigli et al. 1986).

The recommended toxicological benchmark of 1 mg/kg for thallium was used as the TRV for terrestrial plants (Suter et al. 1993).

7.3.5 Development of TRVs for Organic Contaminants of Potential Concern

The following section summarizes the information used in determining the TRVs for organic contaminants for which toxicological studies were located.

Dioxins/Furans (Tetrahydrofuran). Polychlorinated dibenzodioxins (CDD)s and polychlorinated dibenofurans (CDF)s are chemically classified as halogenated aromatic hydrocarbons. They can be formed as unintentional by-products through a variety of chemical reactions and combustion processes. In general, these compounds have very low water solubility, high octanol-water partition coefficients, and low vapor pressure and tend to bioaccumulate.

The environmental fate and environmental distribution of these compounds are not yet well understood. CDDs/CDFs entering the atmosphere are removed either by photodegradation or by deposition. In soil, sediment, and the water column, CDDs/CDFs are primarily associated with particulate and organic matter because of their high lipophilicity and low water solubility. Because of their very low water solubilities and vapor pressures, CDDs/CDFs below the soil surface are strongly absorbed and show little upward or downward vertical migration. Burial in-place, resuspension back into the air, or erosion of soil to water bodies appears to be the predominant fate of CDDs/CDFs sorbed to soil. When entering the aquatic environment, most are associated with particulate matter and are likely to remain sorbed to the particulate matter once in the aquatic environment. They primarily undergo sedimentation and burial. The ultimate environmental sink of CDDs/CDFs is believed to be aquatic sediments.

These compounds exhibit little potential for significant leaching or volatilization once sorbed to particulate matter and are extremely stable under most environmental conditions. The only environmentally significant transformation process is believed to be photodegradation of nonsorbed species in the gaseous phase, at the soil-air or water-air interface, or in association with organic cosolvents.

TRV values for 2,3,7,8-Tetrachloro dibenzodioxin were used for Tetrahydrofuran in the organic screening. The following discussion is for 2,3,7,8-Tetrachloro dibenzodioxin. 2,3,7,8-Tetrachloro dibenzodioxin is a confirmed carcinogen with experimental carcinogenic, neoplastigenic, tumorigenic, and teratogenic data. One of the most toxic synthetic chemicals. A deadly experimental poison by ingestion, skin contact, and intraperitoneal routes. It is very toxic to some animals, with an LD50 of only about 0.6 μg/kg body mass in male guinea pigs. The type and degree of its toxicity to humans in largely unknown; it is known to cause a severe skin condition called chloracne. Human systemic effects by skin contact (allergic dermatitis). Experimental reproductive effects. Human mutation data reported. Also, TCDD is a known eye irritant.

Total tetrachlorodibenzodioxins (TCDD-TOT) have a risk-based concentration of 4.0E-7 ug/L (Region III, EPA, 1995 tables of screening-level RBCs); the carcinogenic slope factor for oral ingestion of TCDD is 1.56E+5 $(mg/kg/d)^{-1}$. There is also a maximum contaminant level (MCL) of 3E-08 mg/L

assigned to total TCDD-TOT. Research into health effects for tetrachlorodibenzodioxins, particularly 2,3,7,8-TCDD, is as follows.

Tetrachloridbenzo-p-dioxin has been shown to be extremely toxic to a number of animal species, the acute oral LD50 values ranging from 0.0006 to 0.283 mg/kg, the guinea pig being the most susceptible species. However, it should be emphasized that mortality does not occur immediately, the animals undergoing a slow but progressive decline into a moribund state associated with an increased incidence of infections and the eventual death some 14 to 28 days after treatment.

Rodents exposed to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) demonstrated severe thymus atrophy. Histologic evaluation of the thymus revealed cortical lymphoid depletion similar to cortisone-induced thymus atrophy. Depressed antibody responses, graft-versus-host, and lympho-proliferative responses were observed at slightly higher doses of TCDD. In addition, increased susceptibility to challenge with the bacteria salmonella bern was noted at low dosages. Depressed antibody responses were also observed in guinea pigs receiving cumulative dosages of TCDD as low as 0.32 μg/kg over an eight-week period. Depressed T-cell function was observed following exposure of adult mice to TCDD, which was associated with an increase in suppressor T-lymphocyte expression and loss of T-lymphocyte cytotoxicity for tumor target cells. Depressed antibody responses and depressed lymphoproliferative responses to mitogens without alteration in cytotoxicity for tumor cells or susceptibility to bacterial or tumor cell challenge in mice exposed to TCDD has been observed by other researchers as well. Decreased antibody plaque responses with no effect on macrophage or NK cell function in TCDD-treated mice have been observed. These results are consistent with an increased susceptibility of TCDD-exposed mice to infection with influenza virus and a lack of effect on a Listeria bacterial challenge. TCDD, and other dioxin isomers, may also suppress serum complement levels in mice, resulting in an increased susceptibility to challenge with Streptococcus pneumoniae infection in these animals.

Exposure to TCDD during thymic organogenesis in rodents has resulted in more severe CMI suppression than that occurring following adult exposure. In some species, in utero exposure via maternal dosing appears to be necessary to induce maximum immunosuppression. At higher dosages, antibody responses and bone marrow stem cell numbers are depressed in most species. Administration of TCDD in utero also results in decreased resistance of offspring to bacterial and tumor cell challenge which correlates with altered CMI in these mice.

Polyaromatic Hydrocarbons. Polyaromatic hydrocarbons (PAHs) are a group of chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. PAHs can be manmade or occur naturally. Some of the PAHs are used in medicines and others are used to make dyes, plastics, and pesticides. They are found throughout the environment in the air, water, and soil. Most PAHs do not occur alone in the environment, rather they are found as mixtures of two or more PAHS. They can occur in the air attached to dust particles or in soil or sediment as solids. They can also be found in substances such as crude oil, coal tar pitch, creosote, and road and roofing tar. Most PAHs do not dissolve easily in water, but some PAHs readily evaporate into the air. PAHs generally do not burn easily and they will last in the environment for months to years (ATSDR 1992b). Methylnaphthalene, acenaphthalene, benzo(a)pyrene, naphthalene, phenanthrene and pyrene are all classified as PAHS. Soil and organic matter strongly sorb PAHS. Higher molecular weight PAHs tend to have lower solubilities in water. Hydrophobic PAHs have a high affinity for binding to organic matter and have relatively high biotransformation rates. Although organic matter is likely to sorb most of the pyrene that partitions into water, biodegradation of pyrene in water can be an important degradative pathway. The dominant mechanism of PAH removal from soil is microbial degradation. PAHs can persist soils for years. The low

solubility, low vapor pressure, and high octanol-water partition coefficient of pyrene results in its partitioning mainly between soil, with a small fraction partitioning into water and air.

PAHs accumulate from soil into roots, which will translocate them into other vegetation parts (Eisler 1987b). In general, unsubstituted PAHs do not tend to accumulate in mammalian adipose tissues despite their high lipid solubility (Eisler 1987b). This is probably because PAHs are rapidly and extensively metabolized. Numerous PAHs are distinct in their ability to produce tumors in most mammal species tested. Acute and chronic exposure to various carcinogenic PAHs has resulted in destruction of the hematopoietic and lymphoid tissues, ototoxicity, respiratory epithelia, and other effects (Eisler 1987b). For the most part, tissue damage occurs at dose levels expected to cause cancer; therefore, the threat of malignancy is the predominant health effect of concern. Target organs affected by PAHs are diverse, probably because of the widespread distribution of PAHs in the body and selective attack by PAHs on proliferating cells. Laboratory studies with mice show that many PAHs affect animals immune systems.

7.3.6 Identifying Uncertainty Associated with TRVs

Although QCEs should be derived from the best available literature and all the uncertainties that could be reasonably accounted for are included in the AFs used to calculate TRVs, it is unlikely that any single scheme could suffice to extrapolate available toxicity data for all chemicals among all species. Thus, the remaining uncertainty in these criteria may be even greater than that associated with exposure estimation. Some of the extrapolations required in TRV development are listed in Table 7-19. TRVs are

Table 7-19. Extrapolations required for developing TRVs.[a]

Extrapolation	Example
Between taxonomic groups	From laboratory mouse to field mouse
Between responses to stressor	From mortality in dogs to a no-observed-effect-level in bobcats
Between laboratory and field conditions	From cage to steppe
Between individual animals to population	From decreased growth rate in captive individuals to effects on a wild population
Between short- and long-term exposure conditions	From acute or subchronic toxicity tests to lifetime exposure
Between laboratory and natural exposure media	Percent uptake of chemical mixed with laboratory diet vs. adsorbed to soil
Between spatial scales	Evaluation of the impact of exposure to a contaminated field on predators for which the foraging range is 50 times as large

a. Adapted from the EPA (1992).

themselves dependent not only on extrapolation procedures but also on sampling adequacy and analytic accuracy, and the completeness and accuracy of response measurements in variable populations of test organisms. Combining results from different species, gathered under different experimental conditions, and extrapolation of results in test organisms to populations of resident species introduce additional, potentially significant sources of error as follows:

- While classical human toxicology relies on extrapolation of toxicity data from a handful of mammalian species to one species, an ecotoxicological evaluation must rely on extrapolation from a few test species to a larger number of receptor species spanning variable (and often large) ranges of phylogeny, anatomy, physiology, and life histories. Further, the spatial and temporal heterogeneity of exposure and conditions in natural systems can cause large variations in the doses and responses observed.

- Organisms in the environment are rarely (if ever) exposed to pure compounds alone, but rather to complex mixtures of chemicals for which the effects in combination are unknown.

- Chemicals may be volatilized, and transformed to more or less toxic products sequestered in the environment.

Our lack of knowledge of environmental variables and limited ability to replicate them in the laboratory or control them in the field results in a high level of uncertainty in our predictions of the effects of stressors on any given ecosystem component from laboratory toxicity tests.

7.4 Risk Characterization

Risk characterization is the final step of the WAG ERA process. The risk evaluation determines whether there is any indication of risk due to the contaminant concentrations and the calculated dose for the INEEL functional groups, T/E, and C2 species and discusses the uncertainty inherent in the assessment. For a WAG ERA, the risk characterization step has two components starting with a description of the estimation of risk. A summary of the risk evaluation follows the risk estimation. These two components are described in the following sections.

7.4.1 Risk Estimation

An estimation of risk is made by comparing the calculated dose to TRV. Exposure parameters used to calculate dose to functional groups, and T/E and C2 species are outlined in Section 7.2. Soil concentration data calculated in the human health risk assessment were used to calculate dose to ecological receptors at each site. The results of the dose calculations are presented in Appendix I. The use of chemical concentration data calculated for human health risk assessment is assumed to be representative of the range of concentrations to which ecological receptors using a site at WAG 1 are likely to be exposed. If the dose from the contaminant does not exceed its TRV (i.e., HQs are less than 1.0 for nonradiological contaminants and 0.1 for radiological contaminants), adverse effects to ecological receptors from exposure to that contaminant are not expected, and no further evaluation of that contaminant is required. Hence, the HQ is an indicator of potential risk. TRVs are developed in Appendix G and discussed in Section 7.3.5. HQs are calculated using the following equation:

$$HQ = \frac{Dose}{TRV} \quad (7\text{-}11)$$

where

HQ = hazard quotient (unitless)

Dose = dose from all media (mg/kg/day or pCi/g/day)

TRV = toxicity reference value (mg/kg/day or pCi/g/day).

HQs are derived for all contaminants, functional groups, and T/E and C2 species identified in WAG 1 for each site of concern. The HQs from the results of the risk analysis are presented in Appendix I. If information was not available to derive a TRV, then an HQ could not be developed for that particular contaminant and functional group or sensitive species combination. These are indicated in the Appendix I tables and Table 7-20 presents a summary of these results.

An HQ greater than the target value indicates that exposure to a given contaminant (at the concentrations and for the duration and frequencies of exposure estimated in the exposure assessment) may cause adverse health effects in exposed populations. However, the level of concern associated with exposure may not increase linearly as HQ values exceed the target value. This means that the HQ values cannot be used to represent a probability or a percentage because an HQ of 10 does not necessarily indicate that adverse effects are 10 times more likely to occur than an HQ of 1. It is only possible to infer that the greater the HQ the greater the concern about potential adverse effects to ecological receptors.

7.4.2 Uncertainty Association With Hazard Quotients

For a WAG ERA an HQ is used as an indicator of risk. The HQ is a ratio of the calculated dose for a receptor from a COPC to the TRV. These ratios provide a quantitative index of risk to defined functional groups or individual receptors under assumed exposure conditions. The ratio, or HQ method, is commonly used in both human health and ERAs. It is used in WAG ERAs to eliminate contaminants and sites that do not pose a risk to the ecosystem from further assessment.

In general, the significance of exceeding a target HQ (Table 7-14) value depends on the perceived, "value" (ecological, social, or political) of the receptor, the nature of the endpoint measured, and the degree of uncertainty associated with the process as a whole. Therefore, the decision to take no further action, order corrective action, or perform additional assessment should be approached on a site-, chemical-, and species-specific basis. Because the unit of concern in ERA is usually the population as opposed to the individual, with the exception of T/E species (EPA 1992), exceeding conservative screening criteria does not necessarily mean that significant adverse effects are likely.

An HQ less than the target value (traditionally 1.0 for nonradionuclide contaminants) implies "low likelihood" of the adverse effects from that contaminant. Nonradiological and radiological contaminants are treated separately because these two classes of contaminants cause different effects in exposed receptors. The effects from the nonradioactive metals are expected to cause systemic toxicity, while the effects to reproductive processes are typically associated with exposure to ionizing radiation. A separate approach in which the target HQ is set to 1/n, where n is the number of nonradiological or radiological contaminants of concern, could also be used. This approach would be too conservative for nonradiological contaminants because it assumes cumulative (simultaneous) exposure to all nonradionuclides and that all

Table 7-20. Summary of WAG 1 ERA results.

	Nonradionuclide		Radionuclide internal		Radionuclide external	
Site	Contaminant	HQ[a]	Contaminant	HQ	Contaminant	HQ
LOFT-02	Copper	<1 to <20	None	—	None	—
	Fluoride	<1 to >20	—	—	—	—
	Manganese	<1 to <20	—	—	—	—
TSF-03	Lead	<1 to >200	None	—	None	—
	2-Methylnaphtalene	<1 to <10	—	—	—	—
TSF-06 (Area 7)	None exceeded target value	—				
TSF-07	Arsenic	<1 to <30	Initially screened	—	Initially screened	—
	Aluminum	<1 to <2,000				
	Antimony	<1 to <30				
	Barium	<1 to <90,000				
	Benzo(b)fluoranthene	<1 to <10				
	Cadmium	<1 to <6,000				
	Cobalt	<1 to <40				
	Copper	<1 to <500				
	Cyanide	<1 to <20				
	Lead	<1 to <900				
	Nickel	<1 to <30				
	Mercury	<1 to <200	—	—	—	—
	Nickel	<1 to <300				
	Selenium	<1 to <500				
	Silver[b]	<1 to <100				
	Strontium	<1 to <10				
	Tetrahydrofuran	<1 to <20,000	—	—	—	—
	Thallium	<1 to <400	—	—	—	—
	Tin	<1 to <300				
	Vanadium	<1 to <90				

Table 7-20. (continued)>

Site	Nonradionuclide		Radionuclide internal		Radionuclide external	
	Contaminant	HQ[a]	Contaminant	HQ	Contaminant	HQ
	Zinc	<1 to <400				
TSF-08	Mercury	<1 to <300	Initially screened	—	Initially screened	—
TSF-22	None exceeded target value	—	Initially screened	—	Initially screened	—
WRRTF-01	Chromium III	<1 to <300	Initially screened	—	Initially screened	—
	Chromium VI	<1 to <300	—	—	—	—
	Lead	<1 to >4,000	—	—	—	—
	2-Methylnaphthalene	<1 to <300	—	—	—	—
WRRTF-03	Cadmium	<1 to >4,000	None	—	None	—
	Chromium III	<1 to <100	—	—	—	—
	Chromium VI	<1 to <100	—	—	—	—
	Silver	<1 to <20	—	—	—	—
WRRTF-13	2-Methylnaphthalene	<1 to <1,000	None	—	None	—
	TPH	<1 to <200	—	—	—	—

a. This represents the maximum HQs calculated across functional groups and T/E species.

b. At TSF-07 the average silver concentration also exceeded AWQC (AWQC = 0.12 µg/L, average silver concentration = 20.5 µg/L).

contaminants within a given group behave synergistically in a given receptor. Given that all receptors thin a functional group may not be simultaneously exposed to all contaminants, and that a synergistic effect may not be seen, this approach may be more stringent than necessary to protect all ecological receptors from nonradiological effects. Therefore, the HQ is set to 1 for all nonradiological contaminants. This method may underestimate risk because the method does not account for cumulative exposure to multiple contaminants by a given receptor.

At this level in the ERA approach at the INEEL, both exposure and toxicity assumptions are generally "worst case," and represent the upper bound of potential risks to ecological receptors. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and, therefore, does not represent a statistical probability of occurrence of adverse ecological effects. HQs provide essentially a "yes or no" determination of risk and are, therefore, well suited for screening-level assessments (EPA 1988b). A limitation of the quotient method is that it does not predict the degree of risk or the magnitude of effects associated with specified levels of contamination (EPA 1988b), However, "modified quotient methods" are available that attempt to address this issue. For example, in the study of toxicity in fish, a method is used (Barnthouse et al. 1986) in which the conclusions are expressed as "no concern," "possible concern," and "high concern," depending on the ratio of the contaminant concentration to the reference (Barnthouse et al. 1986).

A summary of the WAG ERA results is provided in Table 7-20. This table shows the order of magnitude for the largest observed HQ across all functional groups within the site may vary by at least three orders of magnitude. The raw HQ results are shown in Appendix I.

7.4.3 Risk Evaluation

This section describes the results of the evaluation of risk associated with exposure of the functional groups, and T/E and C2 species to contaminants. The initial screening eliminated five organic contaminants, three metals, and all radionuclides. This resulted in twelve sites being eliminated from the assessment [TSF-06 (six of seven areas), TSF-09/18, TSF-26, TSF-29, TSF-36, and TSF-37]. The remaining LOFT-12 site was assessed subsequently in the WAG 1 ERA. Of the remaining sites, two were totally eliminated from further assessment (TSF-06, Area 7 and TSF-22, see Table 7-20). In summary, the seven sites that have HQs greater than 1.0 from contamination include TSF-08, TSF-03, TSF-07, LOFT-02, WRRTF-01, WRRTF-03 and WRRTF-13. All of the retained sites, with the exception of WRRTF-13, have HQs greater than 1.0 for receptors' exposure to metals in soil. Metals that appear to present the greatest potential for adverse effects include arsenic, cadmium, chromium (III and VI), fluoride, lead, manganese, mercury, silver, and thallium. The sites that have HQs greater than 1.0 from organic contamination include TSF-03 (2-methylnaphthalene), TSF-07 (tetrahydrofuran), WRRTF-01 (2-methylnaphthalene), and WRRTF-13 (2-methylnaphthalene and TPH). Each site with HQs greater than 1.0 is discussed in detail below. Table 7-21 presents the hazard quotients that are greater than 1.0 for all seven sites.

7.4.3.1 LOFT-02 (OU1-04, LOFT Disposal Pond). The LOFT Disposal Pond is an active disposal pond which is currently receiving sanitary wastewater and boiler blowdown liquid from the SMC operations. The site is approximately 10,000 m2 (3 acres). There is documented use of the pond by wildlife including waterfowl, shorebirds, swallows and passerines, raptors (to a limited extent), and large mammals including coyote, muskrat, and pronghorn (Cieminski 1993). It is also expected that the pond would be utilized by bat species, although their presence has not been documented. Metals, radionuclides, acetone and toluene have been detected in surface water at the LOFT-02 pond (DOE 1996). Chemical concentrations in surface water at LOFT-02 did not exceed EBSLs for wildlife ingestion of drinking water

Table 7-21. TSF-08 Hazard Quotients

Receptors/Functional Groups	Mercury
site size 90 m^2	
site conc. (mg/kg)	59.00
background (mg/kg)	0.07
Amphibians (A232)	NA
Avian insectivores (AV221)	**2.1**
Avian insectivores (AV222)	**1.1**
Mammalian herbivores (M122)	**4.6**
Mammalian herbivores (M122A)	**3.9**
Mammalian herbivores (M123)	**3.7**
Townsend's western big-eared bat	**2.3**
Small-footed myotis	**3.3**
Long-eared myotis	**2.9**
Mammalian insectivores (M222)	**289.3**
Mammalian omnivores (M422)	**7.0**
Reptilian insectivores (R222)	NA
Sagebrush lizard	NA
Reptilian carnivores (R322)	NA
Plants	**196.7**

Bold indicates HQ > 1.0

Table 7-21. (continued) TSF-07 Hazard Quotients

Receptors/Functional Groups	Arsenic	Mercury	Tetrahydrofuran	Thallium
site size 9,800 m^2				
site conc. (mg/kg)	14.30	2.08	0.02	48.20
background (mg/kg)	7.40	0.07	NA	0.68
Amphibians (A232)	NA	NA	NA	NA
Avian herbivores (AV121)	0.0	0.1	1.2	0.1
Avian herbivores (AV122)	0.2	3.8	70.4	7.2
Trumpeter swan	0.0	0.1	3.3	0.3
Avian insectivores (AV210)	0.5	0.1	210.9	21.7
Black tern	0.0	0.6	42.1	4.3
Avian insectivores (AV210A)	1.6	0.4	678.7	69.8
Avian insectivores (AV221)	4.5	1.1	1862.4	191.5
Avian insectivores (AV222)	6.5	1.7	2692.8	276.9
Avian insectivores (AV222A)	4.2	1.1	1751.8	180.2
Avian carnivores (AV310)	0.0	0.0	5.0	0.0
Peregrine falcon	0.0	0.0	4.5	0.0
Avian carnivores (AV322)	0.0	0.2	182.4	0.4
Loggerhead shrike	0.1	0.2	233.4	0.6
Avian carnivores (AV322A)	0.0	0.0	26.1	0.1
Burrowing Owl	0.0	0.0	26.1	0.1
Avian omnivores (AV422)	0.3	0.1	56.6	5.9
Mammalian herbivores (M121)	0.0	0.0	1.6	0.0
Mammalian herbivores (M122)	1.0	4.2	1259.3	22.8
Mammalian herbivores (M122A)	1.1	4.6	1396.7	25.2
Pygmy rabbit	0.1	0.5	149.5	2.7
Mammalian herbivores (M123)	0.7	2.9	870.0	15.7
Mammalian insectivores (M210)	1.7	3.4	2171.0	39.2
Mammalian insectivores (M210A)	1.7	3.3	2105.5	38.1
Townsend's western big-eared bat	4.7	9.0	5891.5	106.5
Small-footed myotis	6.7	12.8	8392.1	151.7
Long-eared myotis	5.8	11.1	7260.0	131.2
Mammalian insectivores (M222)	14.7	140.5	18477.6	334.0
Mammalian carnivore (M322)	0.0	1.3	469.6	0.7
Mammalian omnivores (M422)	5.9	19.7	71.1	129.8
Mammalian omnivores (M422A)	0.1	0.4	133.3	2.4
Reptilian insectivores (R222)	NA	NA	NA	NA
Sagebrush lizard	NA	NA	NA	NA
Reptilian carnivores (R322)	NA	NA	NA	NA
Plants	1.4	6.9	NA	48.2

Bold indicates HQ > 1.0

Table 7-21. (continued) TSF-03 Hazard Quotients

Receptors/Functional Groups	Lead	2-Methylnaphthalene
site size 155 m^2		
site conc. (mg/kg)	1,130.00	1.66
background (mg/kg)	23.00	NA
Amphibians (A232)	NA	NA
Avian herbivores (AV122)	**4.4**	NA
Avian herbivores (AV132)	0.0	NA
Avian herbivores (AV142)	0.0	NA
Avian herbivores (AV143)	0.0	NA
Trumpeter swan	0.2	NA
Avian insectivores (AV210)	**3.1**	NA
Black tern	**1.2**	NA
Avian insectivores (AV210A)	**5.1**	NA
Avian insectivores (AV221)	**210.5**	NA
Avian insectivores (AV222)	**118.4**	NA
Avian insectivores (AV222A)	**71.4**	NA
Avian insectivores (AV232)	0.0	NA
Avian insectivores (AV233)	0.0	NA
White-faced ibis	0.0	NA
Avian insectivores (AV241)	0.0	NA
Avian insectivores (AV242)	0.0	NA
Avian carnivores (AV310)	0.2	NA
Northern goshawk	0.0	NA
Peregrine falcon	0.1	NA
Avian carnivores (AV322)	**6.9**	NA
Bald eagle	0.0	NA
Ferruginous hawk	0.0	NA
Loggerhead shrike	**8.8**	NA
Avian carnivores (AV322A)	0.9	NA
Burrowing Owl	0.9	NA
Avian carnivores (AV333)	0.0	NA
Avian carnivores (AV342)	0.0	NA
Avian omnivores (AV422)	**3.5**	NA
Avian omnivores (AV432)	0.0	NA
Avian omnivores (AV433)	0.0	NA
Avian omnivores (AV442)	0.0	NA
Mammalian insectivores (M222)	**4.6**	**5.8**
Reptilian insectivores (R222)	NA	NA
Sagebrush lizard	NA	NA
Reptilian carnivores (R322)	NA	NA
Plants	**22.6**	NA

Bold indicates HQ > 1.0

Table 7-21. (continued) LOFT-02 Hazard Quotients

Receptors/Functional Groups	Copper	Fluoride	Manganese
site size 10,000 m^2			
site conc. (mg/kg)	33.00	99.00	1,080.00
background (mg/kg)	32.00	NA	700.00
Amphibians (A232)	NA	NA	NA
Avian insectivores (AV210)	0.2	1.7	0.1
Black tern	0.0	0.3	0.0
Avian insectivores (AV210A)	0.6	5.5	0.3
Avian insectivores (AV221)	**1.6**	**14.8**	0.8
Avian insectivores (AV222)	**2.4**	**21.4**	**1.4**
Avian insectivores (AV222A)	**1.5**	**13.9**	0.9
Loggerhead shrike	0.0	**1.3**	0.1
Mammalian herbivores (M122)	0.9	0.2	**4.7**
Mammalian herbivores (M122A)	**1.1**	0.2	**5.2**
Pygmy rabbit	0.1	0.0	0.6
Mammalian herbivores (M123)	0.7	0.1	3.3
Mammalian insectivores (M210)	**1.7**	0.3	**2.2**
Mammalian insectivores (M210A)	**1.6**	0.3	**2.1**
Townsend's western big-eared bat	**4.6**	0.9	**5.8**
Small-footed myotis	**6.5**	**1.2**	**8.2**
Long-eared myotis	**5.6**	**1.1**	**7.1**
Mammalian insectivores (M222)	**14.1**	**2.6**	**18.5**
Mammalian omnivores (M422)	**8.2**	**1.5**	**8.8**
Reptilian insectivores (R222)	NA	NA	NA
Sagebrush lizard	NA	NA	NA
Reptilian carnivores (R322)	NA	NA	NA
Plants	NA	NA	NA

Bold indicates HQ > 1.0

Table 7-21. (continued) WRRTF-01 Hazard Quotients

Receptors/Functional Groups	Chromium III	Chromium VI	Lead	2-Methylnaphthalene
site size 2,520 m^2				
site conc. (mg/kg)	264.00	264.00	2,350.00	10.30
background (mg/kg)	50.00	NA	23.00	NA
Amphibians (A232)	NA	NA	NA	NA
Avian herbivores (AV121)	0.0	NA	**2.6**	NA
Avian herbivores (AV122)	0.4	NA	**148.3**	NA
Avian herbivores (AV132)	0.0	NA	0.0	NA
Avian herbivores (AV142)	0.0	NA	0.0	NA
Avian herbivores (AV143)	0.0	NA	0.0	NA
Trumpeter swan	0.0	NA	**7.0**	NA
Avian insectivores (AV210)	0.1	NA	**104.6**	NA
Black tern	0.1	NA	**42.2**	NA
Avian insectivores (AV210A)	0.3	NA	**172.0**	NA
Avian insectivores (AV221)	**3.3**	NA	**3671.9**	NA
Avian insectivores (AV222)	**5.3**	NA	**4004.5**	NA
Avian insectivores (AV222A)	**3.2**	NA	**2414.5**	NA
Avian insectivores (AV232)	0.0	NA	0.0	NA
Avian insectivores (AV233)	0.0	NA	0.0	NA
White-faced ibis	0.0	NA	0.0	NA
Avian insectivores (AV241)	0.0	NA	0.0	NA
Avian insectivores (AV242)	0.0	NA	0.0	NA
Avian carnivores (AV310)	0.0	NA	**6.4**	NA
Northern goshawk	0.0	NA	0.6	NA
Peregrine falcon	0.0	NA	**4.3**	NA
Avian carnivores (AV322)	0.2	NA	**233.5**	NA
Bald eagle	0.0	NA	0.2	NA
Ferruginous hawk	0.0	NA	0.8	NA
Loggerhead shrike	0.3	NA	**298.9**	NA
Avian carnivores (AV322A)	0.0	NA	**33.7**	NA
Burrowing Owl	0.0	NA	**33.7**	NA
Avian carnivores (AV333)	0.0	NA	0.0	NA
Avian carnivores (AV342)	0.0	NA	0.0	NA
Avian omnivores (AV422)	0.1	NA	**118.1**	NA
Avian omnivores (AV432)	0.0	NA	0.0	NA
Avian omnivores (AV433)	0.0	NA	0.0	NA
Avian omnivores (AV442)	0.0	NA	0.0	NA
Mammalian herbivores (M122)	0.0	**99.7**	**16.4**	**19.5**
Mammalian herbivores (M122A)	0.0	**92.9**	**15.3**	**18.1**
Pygmy rabbit	0.0	**10.7**	**1.8**	**2.1**
Mammalian herbivores (M123)	0.0	**68.9**	**11.4**	**13.4**
Mammalian insectivores (M210)	0.0	**3.5**	**2.3**	**8.6**
Mammalian insectivores (M210A)	0.0	**3.4**	**2.2**	**8.4**
Townsend's western big-eared bat	0.0	**8.3**	**6.1**	**23.4**
Small-footed myotis	0.0	**11.9**	**8.6**	**33.3**
Long-eared myotis	0.0	**10.3**	**7.5**	**28.8**
Mammalian insectivores (M222)	0.0	**120.8**	**76.4**	**285.5**
Mammalian carnivore (M322)	0.0	**2.5**	0.0	**1.9**
Mammalian omnivores (M422)	0.0	**52.9**	**21.3**	**58.2**
Reptilian insectivores (R222)	NA	NA	NA	NA
Sagebrush lizard	NA	NA	NA	NA
Reptilian carnivores (R322)	NA	NA	NA	NA
Plants	**264.0**	**264.0**	**47.0**	NA

Bold indicates HQ > 1.0

Table 7-21. (continued) WRRTF-03 Hazard Quotients

Receptors/Functional Groups	Cadmium	Chromium III	Chromium VI	Silver
site size 5,574 m^2				
site conc. (mg/kg)	11.70	78.90	78.90	18.00
background (mg/kg)	3.70	50.00	NA	NA
Amphibians (A232)	NA	NA	NA	NA
Avian herbivores (AV121)	0.0	0.0	NA	NA
Avian herbivores (AV122)	**2.7**	0.2	NA	NA
Avian herbivores (AV132)	0.0	0.0	NA	NA
Avian herbivores (AV142)	0.0	0.0	NA	NA
Avian herbivores (AV143)	0.0	0.0	NA	NA
Trumpeter swan	0.1	0.0	NA	NA
Avian insectivores (AV210)	**13.4**	0.1	NA	NA
Black tern	**2.6**	0.0	NA	NA
Avian insectivores (AV210A)	**43.2**	0.2	NA	NA
Avian insectivores (AV221)	**208.2**	0.9	NA	NA
Avian insectivores (AV222)	**299.4**	**2.4**	NA	NA
Avian insectivores (AV222A)	**194.8**	**1.6**	NA	NA
Avian insectivores (AV232)	0.0	0.0	NA	NA
Avian insectivores (AV233)	0.0	0.0	NA	NA
White-faced ibis	0.0	0.0	NA	NA
Avian insectivores (AV241)	0.0	0.0	NA	NA
Avian insectivores (AV242)	0.0	0.0	NA	NA
Avian carnivores (AV310)	0.5	0.0	NA	NA
Northern goshawk	0.1	0.0	NA	NA
Peregrine falcon	0.5	0.0	NA	NA
Avian carnivores (AV322)	**19.9**	0.1	NA	NA
Bald eagle	0.0	0.0	NA	NA
Ferruginous hawk	0.1	0.0	NA	NA
Loggerhead shrike	**25.5**	0.2	NA	NA
Avian carnivores (AV322A)	**2.8**	0.0	NA	NA
Burrowing Owl	**2.8**	0.0	NA	NA
Avian carnivores (AV333)	0.0	0.0	NA	NA
Avian carnivores (AV342)	0.0	0.0	NA	NA
Avian omnivores (AV422)	0.4	0.1	NA	NA
Avian omnivores (AV432)	0.0	0.0	NA	NA
Avian omnivores (AV433)	0.0	0.0	NA	NA
Avian omnivores (AV442)	0.0	0.0	NA	NA
Mammalian herbivores (M122)	**276.3**	0.0	**29.8**	0.8
Mammalian herbivores (M122A)	**306.4**	0.0	**33.1**	0.9
Pygmy rabbit	**32.8**	0.0	**3.5**	0.1
Mammalian herbivores (M123)	**190.9**	0.0	**20.6**	0.6
Mammalian insectivores (M210)	**297.4**	0.0	**2.3**	0.8
Mammalian insectivores (M210A)	**288.5**	0.0	**2.2**	0.8
Townsend's western big-eared bat	**807.9**	0.0	**5.5**	**2.2**
Small-footed myotis	**1150.8**	0.0	**7.8**	**3.1**
Long-eared myotis	**995.5**	0.0	**6.8**	**2.7**
Mammalian insectivores (M222)	**4449.1**	0.0	**36.1**	**12.0**
Mammalian carnivore (M322)	**107.3**	0.0	**1.7**	0.1
Mammalian omnivores (M422)	**2642.4**	0.0	**35.0**	**3.6**
Mammalian omnivores (M422A)	**36.4**	0.0	0.3	0.0
Reptilian insectivores (R222)	NA	NA	NA	NA
Sagebrush lizard	NA	NA	NA	NA
Reptilian carnivores (R322)	NA	NA	NA	NA
Plants	**3.9**	**78.9**	**78.9**	**9.0**

Bold indicates HQ > 1.0

(Sample et al. 1996). Therefore, no risk is expected to wildlife exposed to contaminants in drinking water at LOFT-02.

Metals, radionuclides, and few organics were detected in sediment sampled from the LOFT-02 pond during the Track 2 investigation (DOE, 1996). Sediment analytical results for the LOFT-02 pond were compared to INEEL background concentrations from the Track 2 document (DOE, 1996) and EBSLs for screening contaminants of potential concern for effects on sediment-associated organisms (Jones et al. 1996, Long et al. 1995, and Persaud et al. 1990). Radionuclide concentrations were within INEEL background ranges. All organics were detected at concentrations below the sediment EBSLs. Average manganese and silver concentrations in sediment exceeded both background and the EBSLs, indicating a potential risk to sediment-associated organisms from exposure to these metals. However, the average manganese concentration barely exceeded background (713 mg/kg versus 700 mg/kg) and the background concentration also exceeded the EBSL (460 mg/kg) for manganese. This suggests that the level of risk resulting from exposure by benthic organisms to manganese in LOFT Disposal Pond sediment is about the same as that from exposure to background concentrations. The average silver concentration in sediment (1.4 mg/kg) was also only slightly greater than the EBSL (1.0 mg/kg). It should also be noted that the silver EBSL is the very conservative Effects Range-Low (ER-L) (Long et al. 1995) that is representative of effects in 5% of the benthic organisms tested, most of which are estuarine species. For these reasons, maganese and silver concentrations in sediment are not believed to present a significant risk to benthic organisms in the LOFT Disposal Pond.

HQs that exceeded 1.0 for the LOFT-02 site included copper, fluoride, and manganese, for various receptors' exposure to soil concentrations of these metals. The copper concentration in soil at LOFT-02 is 33 mg/kg.. The INEEL background soil concentration for copper is 32 mg/kg. Therefore, the risk to ecological receptors for exposure to copper in soil in LOFT-02 is about the same as that posed by exposure to soil background concentrations. The level of risk resulting from exposure to copper in soil would therefore be considered very low to insignificant.

The fluoride concentration in soil at LOFT-02 is 99 mg/kg. There is no INEEL background value for fluoride. HQs were greater than 1.0 for five avian insectivore functional groups (ranging from 1.3 to 21.4), small-footed myotis (1.2), long-eared myotis (1.1), mammalian insectivores (M222) (HQ = 2.6), mammalian omnivores (M422) (HQ = 1.5) . No reptile, amphibian, or plant toxicity data was available for fluoride and TRVs for these species could not be derived.

The manganese concentration in soil at LOFT-02 is 1,080 mg/kg. The INEEL background concentration for manganese is 70 mg/kg. HQs (>1.0) for manganese ranged from 1.4 for avian insectivores (AV222) to 18.5 for mammalian insectivores (M222). No reptile or amphibian toxicity data was available for manganese and TRVs for these species could not be derived.

7.4.3.2 TSF-03 (OU1-03, TSF Burn Pits). The TSF-03 site covers an area that is approximately 155 m^2 in size. At this site, HQs for exposure to lead and 2-methylnapthalene in soil exceeded the target value of 1.0. The lead concentration at the site is 1,130 mg/kg. The INEEL background concentration for lead is 23 mg/kg. HQs greater than 1.0 for exposure to lead in soil at TSF-03 ranged from 1.2 for black tern and 8.8 for loggerhead shrike to210.5 for avian insectivores (AV221). No reptile or amphibian toxicity data was available for lead and TRVs for these species could not be derived.

The 2-methylnapthalene concentration in soil at TSF-03 is 1.66 mg/kg. Only one HQ exceeded the target value for exposure to 2-methylnapthalene and this was 5.8 for mammalian insectivores (M222). No

avian, reptile, amphibian, or plant toxicity data was available for 2-methylnapthalene and TRVs for these species could not be derived.

7.4.3.3 TSF-07 (OU1-06, TSF Disposal Pond). TSF-07 is the 9,800 m2 TSF Disposal Pond site. TSF-07 is an unlined disposal pond, the active portion of which is 1.5 acres in size. There is documented use of the pond by wildlife including waterfowl, shorebirds, swallows and passerines, raptors, and large mammals (Cieminski 1993). It is also expected that the pond would be utilized by bats, although their presence has not been documented. Surface water was sampled in the TSF-07 pond during the Track 1 investigation (DOE, 1992). Metals, radionuclides, and acetone were detected in surface water. Surface water concentrations were compared to AWQC (EPA, 1987) and EBSLs for wildlife ingestion of drinking water (Sample et al. 1996). Average silver and zinc concentrations, 20.5 ug/L and 32.5 ug/L respectively, exceeded AWQC. The zinc concentration was well below the wildlife drinking water EBSL (62,300 ug/L). No EBSL was available for silver. Sediment chemical concentration data was not available for TSF-07.

HQs for ecological receptors' exposure to arsenic, mercury, tetrahydrofuran, and thallium in soil exceeded 1.0. The arsenic concentration in soil at TSF-07 is 14.3 mg/kg. The INEEL background concentration for arsenic in soil is 7.4 mg/kg. Arsenic HQs (>1.0) ranged from 1.0 for mammalian herbivores (M122) to 14.7 for mammalian insectivores (M222). Arsenic HQs also exceed 1.0 for Townsend's western big-eared bat (4.7), small-footed myotis (6.7), and long-eared myotis (5.8), and plants (1.4). No reptile or amphibian toxicity data was available for arsenic and TRVs for these species could not be derived.

The mercury concentration in soil at TSF-07 is 2.08 mg/kg. The INEEL background concentration for mercury is 0.074 mg/kg. HQs greater than 1.0 for exposure to mercury in soil at TSF-07 ranged from 1.1 for avian insectivores to 140.5 for mammalian insectivores (M222). HQs exceeded 1.0 for all three sensitive bat species, ranging from 9.0 to 12.8 for these species. The mercury HQ for plants (6.9) also exceeded the target level. TRVs for mercury were not derived for reptilian receptors or amphibians due to lack of appropriate toxicity data.

The tetrahydrofuran concentration in soil at TSF-07 is 0.022 mg/kg. HQs exceeded 1.0 for the majority of functional groups and sensitive species evaluated (see Table 7-21), indicating a potential for risk to many receptors exposed to tetrahydrofuran. Tetrahydrofuran HQs ranged from 1.2 for avian herbivores (AV121) to 18,478 for mammalian insectivores (M222). No reptile, amphibian, or plant toxicity data was available for tetrahydrofuran and TRVs for these species could not be derived.

The thallium concentration in soil at the TSF Disposal Pond site is 48.2 mg/kg. The INEEL background concentration for thallium is 0.68 mg/kg. Thallium HQs that exceeded 1.0 ranged from 2.4 for mammalian omnivores (M422A) to 334 for mammalian insectivores (M222). HQs were above the target values for black tern (4.3), pygmy rabbit (2.7), the three sensitive bat species (HQs 106.5 to 152), and plants (48.2). HQs could not be determined for reptiles or amphibians due to the lack appropriate toxicity data to derive TRVs.

7.4.3.4 TSF-08 (OU1-06, TSF HTRE III Mercury Spill Area). The TSF-08 site is 90 m2. The mercury concentration in soil at TSF-08 is 59 mg/kg. The INEEL background concentration for mercury is 0.074 mg/kg. HQs for exposure to mercury in soil were greater than 1.0 for two avian insectivore functional groups, three mammalian herbivore groups, the three sensitive bat species, mammalian insectivores (M222), mammalian omnivores (M422), and plants (see Table 7-21). HQs ranged from 1.1 for avian insectivores (AV222) to 289 for mammalian insectivores (M222). HQs could not be determined for reptiles or amphibians due to the lack appropriate toxicity data to derive TRVs.

7.4.3.5 WRRTF-01 (OU1-03, WRRTF Burn Pits). The WRRTF Burn Pits site is approximately 2,520 m2. HQs that exceeded 1.0 at WRRTF-01 included chromium III, chromium VI, lead, and 2-methylnapthalene for ecological receptors' exposure to these chemicals in soil. Chromium III and chromium VI were detected in soil at 264 mg/kg. Soil chemical analysis was for total chromium only. Chromium III and VI concentrations were conservatively assumed to be the same as the total concentration in the absence of specific analyses. The INEEL background concentration for chromium is 50 mg/kg. Avian insectivores (AV221, AV222, AV222A) and plants were the only receptors for which HQs for chromium III exceeded 1.0. HQs ranged from 3.22 for avian insectivores (AV222A) to 264 for plants. HQs for all other species/functional groups were all less than 1.0, indicating no risk to these receptors from exposure to chromium III at WRRTF-01. HQs could not be determined for reptiles or amphibians due to the lack appropriate toxicity data to derive TRVs for chromium III. Additionally, risk resulting from exposure to chromium VI could not be evaluated for avian receptors, reptiles, or amphibians for the same reasons.

HQs for exposure to chromium VI in soil at WRRTF-01 were greater than 1.0 for most mammalian receptors (including the sensitive species), with mammalian HQs ranging from 1.8 for pygmy rabbit to 121 for mammalian insectivores (M222) (see Table 7-21). The HQ for plants' exposure to chromium VI was 264. However, most chromium in soil is expected to be in the trivalent, and less toxic, form. Therefore, these HQs greater than 1.0 for chromium VI are not necessarily good indicators of risk.

The lead concentration in soil at WRRTF-01 is 2,350 mg/kg. The INEEL background concentration for lead in soil is 23 mg/kg. HQs for exposure to lead in soil at WRRTF-01 exceeded the target value of 1.0 for many sensitive receptors and functional groups and plants(see Table 7-21). Lead HQs (>1.0) ranged from 1.8 for pygmy rabbit to over 4,000 for avian insectivores (AV222).

7.4.3.6 WRRTF-03 (OU1-09, WRRTF Evaporation Pond). Site WRRTF-03 is approximately 5,574 m2. HQs for receptors' exposure to cadmium, chromium (III and VI), and silver in soil were greater than 1.0. The cadmium concentration in soil at WRRTF-03 is 11.7 mg/kg. The background concentration of cadmium is 3.7 mg/kg. Cadmium HQs exceeded the target value for several avian insectivore functional groups, black tern, two avian carnivore functional groups, loggerhead shrike, burrowing owl, many mammalian functional groups, pygmy rabbit, the three sensitive bat species, and plants (see Table 7-21). Cadmium HQs (>1.0) ranged from 2.6 for black tern to over 4,000 for mammalian insectivores (M222). Amphibians and reptiles could not be evaluated for exposure to cadmium due to an absence of appropriate toxicity data.

Chromium III and chromium VI were detected in soil at WRRTF-03 at 78.9 mg/kg. Soil chemical analysis was for total chromium only. Chromium III and VI concentrations were conservatively assumed to be the same as the total concentration in the absence of specific analyses. The INEEL background concentration for chromium is 50 mg/kg. Chromium III HQs exceeded 1.0 for avian insectivores (2.4 for AV222 and 1.6 for AV222A) and plants (78.9) only. Amphibians and reptiles could not be evaluated. Chromium VI HQs were determined for mammals and plants only due to an absence of toxicity data for other species. HQs greater than 1.0 for chromium VI ranged from 1.7 for mammalian carnivores (M322) to 35 for mammalian omnivores (M422). HQs for the pygmy rabbit (3.5) and the three sensitive bat species (HQs 5.5 to 7.8) also exceeded the target value.

The silver concentration in soil at WRRTF-03 is 18 mg/kg. There is no INEEL background value for silver. Silver HQs were greater than 1.0 for Townsend's western big-eared bat, small-footed myotis, long-eared myotis, mammalian omnivores (M422), and plants. The HQ values ranged from 2.2 to 12.

Amphibians, reptiles, and birds could not be evaluated for exposure to silver due to an absence of appropriate toxicity data.

7.4.3.7 WRRTF-13 (OU1-08, WRRTF Fuel Oil Leak). The WRRTF Fuel Oil Leak site covers an area of approximately 125 m2. 2-methylnaphthalene and TPH are the contaminants of concern in soil at WRRTF-13. The 2-methylnaphthalene concentration is 290 mg/kg. HQs greater than 1.0 for 2-methylnaphthalene ranged from 1.1 for mammalian omnivores (M422A) to 810 for mammalian insectivores (M222). HQs for pygmy rabbit and all three sensitive bat species also exceeded 1.0. Amphibians, reptiles, birds, and plants could not be evaluated for exposure to 2-methylnaphthalene due to an absence of appropriate toxicity data.

The TPH concentration at the WRRTF Fuel Oil Leak site is 19,800 mg/kg. HQs exceeded 1.0 for seven mammalian functional groups and the three sensitive bat species. HQs (>1.0) ranged from 2.2 for mammalian insectivores (M210 and M210A) to 151 for mammalian insectivores (M222). HQs for amphibians, birds, reptiles, and plants could not be determined because TRVs could not be derived for these receptors.

7.4.4 Discussion of Uncertainty

Uncertainty is inherent in the risk process and has been discussed in detail throughout this document. Principal sources of uncertainty lie within the development of an exposure assessment. Uncertainties inherent in the exposure assessment are associated with estimation of receptor ingestion rates, selection of acceptable HQs, estimation of site usage, and estimation of PUFs and BAFs. Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of TRVs. A large area of uncertainty is the inability to evaluate risk to many receptors due to the lack of appropriate toxicity data for many chemicals. This is especially a problem for amphibians and reptiles. All of these uncertainties likely influence risk estimates. Table 7-22 reviews the major sources and effects of uncertainties in the ERA.

7.4.5 WAG ERA Summary

The objectives of this assessment were to define the extent of contamination for each site at the WAG level; determine the potential effects from contaminants on environmental receptors, habitats, or special environments; determine the potential effects from contaminants to other ecological receptors at the WAG 1; and identify sites and COPCs to be assessed in the INEEL-wide ERA. The approach is an extension of the SLERA methodology used at the INEEL (VanHorn et al. 1995). This methodology uses conservative exposure modeling and input parameters to identify contaminants and sites that may pose a risk to the environment.

The WAG 1 ERA incorporates levels of uncertainty that could either overestimate or underestimate the actual risk to these receptors. To compensate for potential uncertainties, the WAG ERA incorporates various AFs that are designed to be conservative rather than result in a conclusion of no indication of risk when actual risk may exist. Regardless of the inclusion of AFs, other uncertainties exist that could affect the estimation of true risk associated with WAG 1.

The basis of the TRVs developed for nonradionuclides is effect to the individual. This conservative approach is very commonly used because of the large uncertainty inherent in extrapolating effects data from test to field organisms. Conservatism is compounded by the limited level of exposure modeling (i.e., transport of contaminants in the food chain from the subsurface to surface). Using this level of

Table 7-22. Source and effects of uncertainties in the ecological risk assessment.

Uncertainty factor	Effect of uncertainty (level of magnitude)	Comment
Estimation of ingestion rates (soil, water, and food)	May overestimate or underestimate risk (moderate)	Few intake (ingestion estimates used for terrestrial receptors are based on data in the scientific literature (preferably site-specific) when available. Food ingestion rates are calculated by using allometric equations available in the literature (Nagy 1987). Soil ingestion values are generally taken from Beyer et al. (1994).
Estimation of concentration factors and plant uptake factors	May overestimate or underestimate risk and the magnitude of error cannot be quantified (high).	Few BAFs or PUFs are available in the literature because they must be both contaminant- and receptor-specific. In the absence of more specific information, PUFs and BAFs for metals and elements are obtained from Baes et al. (1984), and for organics from Travis and Arms (1988).
Estimation of toxicity reference values	May overestimate (high) or underestimate (moderate) risk	To compensate for potential uncertainties in the exposure assessment, various adjustment factors are incorporated to extrapolate toxicity from the test organism to other species.
Lack of appropriate toxicity data to derive TRVs	Results in the inability to evaluate risk for many receptors and chemicals	Those receptor groups and chemicals which could not be evaluated are data gaps in the assessment.
Use of functional grouping	May overestimate (moderate)	Functional groups were designed as an assessment tool that ensure that the ERA addresses all species potentially present at the facility. A hypothetical species is developed using input values that represent the greatest exposure of the combined functional group members.
Site use factor	May overestimate (high) or underestimate (low) risk	SUF is a percentage of the site of concern area compared to home range of the receptor species. Home range is not known for many species and, therefore, a default of 1.0 is used. This can overestimate the risk at small sites.

analysis and given that individual ecological receptors are represented with greater exposure than human occupational scenarios, with sites exhibiting risk to ecological receptors from nonradionuclides. The assessment of nonradionuclide contaminated sites resulted in assessment endpoints not being attained (HQs greater than one).

The results of this assessment will be used in the development of the OU 10-04 comprehensive RI/FS for performing the INEEL-wide ERA. As part of the OU 10-04 ERA, it is expected that TRV values will be reviewed, less conservative modeling approaches evaluated, and a population and community assessment methodology developed. The results of the SLERAs and WAG ERAs will be summarized and used to direct future sampling in support of the OU 10-04 ERA effort, as well as to evaluate overall risk to INEEL ecological receptors.

At this time there are known sampling data gaps at WAG 1 that would prevent the results from being rolled up into the INEEL-wide ERA. The results of the assessment at this phase will be used to identify data gaps at the INEEL-wide level.

The primary value of the WAG 1 ERA is to provide input into the INEEL-wide ERA. The INEEL-wide ERA is the appropriate level to perform the detailed ecological risk assessment. To address cleanup decisions being made at the WAG level, an effort has been made to include less conservative values to allow more realistic assessment at the WAG level. It is recognized, however, that having the ERA finalized in the OU 10-04 comprehensive RI/FS may result in possible review of prior decisions. The risk of this occurring is unlikely given the extent and nature of the contamination at the INEEL. However, monitoring of ecological resources should be included in any decision, and these results should be reviewed at the appropriate time.

7.5 Transition to INEEL-Wide ERA

The WAG 1 ERA represents the second phase of the three-phased approach to ERA proposed in Figure 7-1. The approach applies an iterative, "tiered" process in which preliminary assessments, based on conservative assumptions, support progressively more refined assessments (Maughn 1993; Opresko et al. 1994; Leven et al. 1989).

The first phase is the SLERA, which is a "preassessment" performed at the WAG level. The SLERA is performed to reduce the number of sites and contaminants to be addressed in subsequent assessments. The SLERA is used only as a preassessment tool to (1) better define the extent and nature of individual WAG sites of contamination and identify sites at which no COPCs are found, (2) reduce the number of COPCs to be addressed in the WAG ERA by eliminating those that clearly pose a low likelihood for risk, (3) identify sites for which further data are needed, and (4) identify other data gaps. SLERAs also serve to support problem formulation and drive media and pathways to be evaluated for WAG ERAs. Because the risk assessment tasks based on the FFA/CO are ongoing and additional sites may be identified, the SLERA is also used to screen new sampling data and additional sites. The SLERA plays no role in setting remedial action levels. Details of SLERA methodology can be found in *Guidance Manual* (VanHorn et al. 1995).

In phase two, the WAG ERA incorporates the SLERA results and assesses potential risks to ecological receptors using an approach that parallels the human health risk assessment methodology for addressing risk to ecological receptors at the WAG level. The WAG ERA applies aspects of the methodologies developed for the SLERA and incorporates the results of the SLERA. The WAG ERA,

however, also duplicates the approach developed for the cumulative human health risk assessments (Burns 1994) by providing a site-by-site assessment of those contaminants that were not eliminated in the SLERA. It is the next level of screening that primarily provides input to the INEEL-wide ERA.

The WAG ERA represents the assessment of the "no action" alternative for remediation at the WAG level. The WAG ERA results (1) provided a list of COPCs to be addressed at the INEEL-wide level and (2) identified WAG 1 level data gaps that may require filling before performing the INEEL-wide ERA. The results of the WAG ERA and associated data gaps will be evaluated and discussed in more detail in the OU 10-04 RI/FS (which is due to agencies by February 27, 1997). The results of the WAG ERA may also support risk assessments to evaluate WAG remedial actions or additional assessments if necessary.

The third phase of the ERA process is the INEEL-wide ERA, which is performed to integrate WAG ERAs to evaluate risk to INEEL-wide ecological resources. This assessment is conducted to evaluate effects resulting from past contamination, and their potential for adversely impacting INEEL-wide ecological resources including residual impacts from completed interim or remedial actions.

The INEEL-wide ERA will integrate the results of the WAG ERAs to determine whether contamination at the WAGs contributes to potential risk to populations and communities on an ecosystem-wide basis (over the entire INEEL). The INEEL-wide ERA is contrasted with the previous phases of the process in Table 7-23.

Table 7-23. Comparison of WAG ERA components for phases of the INEEL-wide ERA.

Component of assessment	SLERA (Phase 1)	WAG ERA (Phase 2)	INEEL-wide baseline ERA (Phase 3)
Stressor and receptor identification (contaminants and sites of potential concern)	Tracks 1 and 2, all FFA/CO sites and contaminants	SLERA COPC and site retention lists	WAG transition ERA COPC and site retention lists
Spatial scale	WAG assessment area	Sites within the WAG assessment area	INEEL-wide or WAG level for individual sites
Temporal scale	Current	Current, future (buried waste)	Current, future (buried waste)
Contaminant concentration in media of interest	Average concentration across the WAG—human health sampling	Average concentration for each site—human health sampling and modeling for buried waste	To be determined.
Exposure assessment	EBSL soil and water	Dose across media	Dose across media
Risk characterization	Screening level quotient (SLQ)—unranked	HQ—ranked	HQ—ranked and qualitative discussion
Cumulative risk	Multiple sites combined across the WAG—average concentration	Multiple contaminants—individual sites—average concentration	Multiple contaminants across multiple WAGs
Assessment endpoints	WAG functional groups and individual T/E species—semiquantitative	WAG functional groups and Individual T/E species—quantitative and qualitative	EPA assessment endpoint criteria (to be determined)—quantitative, semiquantitative, and qualitative
Measurement endpoints	Exposure model parameters	Exposure model parameters	To be determined—ecological components based on assessment endpoints and COPCs from WAG ERAs

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